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THE ILLUMINATING ENGINEER

LIGHT LAMPS FITTINGS AND ILLUMINATION

THE JOURNAL OF

# GOOD LIGHTING

Official Organ of the Illuminating Engineering Society

FOUNDED IN LONDON 1908

Edited by LEON GASTER

OIL GAS ELECTRICITY ACETYLENE PETROL-AIR GAS ETC.

Vol. XX June, 1927

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## Special Features:

Problems in Illuminating Engineering—Developments in Photometry—Visit to the National Physical Laboratory—Stage Lighting Appliances—The Lighting of Shops and Stores—The Development of Gas Supply in Liverpool—News from Abroad, etc.

*Electric Lamps and their Uses. No 4.*

OPAL *and* WHITE SPRAYED *GASFILLED LAMPS*

~~Glare~~

Although clear gasfilled lamps, on account of their great brightness, should be used only with diffusing reflectors and other fittings which afford protection from glare, there are many instances where opal and white sprayed lamps, which are themselves excellent diffusers, should be used. The principle is that of breaking up a light in its passage through the bulb so that the whole bulb becomes, so far as the eye is concerned, a light source.

Lamps of this kind are infinitely more comfortable when in the line of vision, and the sacrifice of light in the process of diffusion is very small. These lamps are of two kinds:—

(1) The gasfilled lamp with a bulb of clear crystal glass, upon which a very thin film of opal glass is superimposed.

(2) The gasfilled lamp which has coated upon the exterior of the bulb a solution of china clay, which, subsequently treated and fixed, forms a white diffusing medium.

The actual position of the filament cannot be detected, and these lamps can be described as anti-glare lamps.

*Issued by the Electric Lamp Manufacturers Association*

# The Hours that Count

Factory efficiency during daylight hours may be very high; *but* it may be altogether discounted by inferior work and output during the hours when artificial light is needed. It is these latter hours, therefore, that count.

Bad or indifferent factory lighting is responsible for slow production, spoiled goods and accidents. Good light will maintain the quality and speed of output, and secure the best of service through the comfort of employees.

Good light is gas light—free from glare and flicker; constant, uniform and softly powerful.

*The foundry illustrated above is lighted by High Pressure Gas Light. Note the evenness of the illumination and the almost entire absence of shadow.*

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# The Development of Photometry

THE great progress that has been made in photometry during recent years was well illustrated, both in the paper read before the Illuminating Engineering Society by Mr. H. Buckley, on April 27th (see p. 177), and in the series of Cantor Lectures delivered by Mr. J. W. T. Walsh before the Royal Society of Arts last month (see p. 172). At the time when the Illuminating Engineering Society was formed, about 18 years ago, the number of people interested in photometry was small, and discussions on this subject usually attracted only small audiences. Photometry was, in fact, regarded by many as an interesting hobby, and little more.

But the way in which members of the Illuminating Engineering Society and their friends "rolled up" on the occasion of the visit to the National Physical Laboratory, and the excellent audiences attracted by Mr. Walsh's Cantor Lectures, showed that the subject is now regarded in a very different light. One of the chief reasons for the change is no doubt the stimulus afforded by meetings of the Illuminating Engineering Society, which have shown that there is practically no lighting problem that can be investigated without the aid of photometric instruments. It is only in the very elementary stages of any science that one can make any material progress without measuring. Illuminating Engineering has long passed this stage.

In the discussion of Mr. Buckley's paper at the National Physical Laboratory several speakers referred to Dr. J. A. Fleming's classic paper on "The Photometry of Electric Lamps," read before the Institution of Electrical Engineers in 1902, as an important landmark. Another great landmark was Mr. Trotter's famous paper on "The Distribution and Measurement of Illumination," read before the Institution of Civil Engineers just ten years earlier (in 1892), and awarded a Telford Medal and Premium. A revised version of Mr. Trotter's paper appeared serially in *The Illuminating Engineer*, starting in the very first issue, in January, 1908. Two years later the Illuminating Engineering Society devoted one of its first meetings to a discussion on "The Measurement of Light and Illumination."

Looking back on these early papers and discussions one is struck, firstly, by the remarkable prescience and individual scientific enterprise of such workers as Mr. Trotter and Dr. Fleming, and, secondly, by the special—one might say lonely—position they occupied as pioneers. Next, one gets the impression that in those days workers in photometry were feeling their way amongst unfamiliar phenomena, and, except for a few experts, there was a general sense of uncertainty about results and lack of information on what are now regarded as fundamental phenomena. One can recall, for example, the many unknown factors in connection with the standards in use, and the differences of opinion expressed in regard to the problem of heterochromatic photometry. And if this was true of laboratory work it was still more true of measurements of illumination, for which scarcely any instruments were available.

Time has brought great changes in these respects. Photometry in the laboratory has become a process of precision, and nowhere more so than in the Photometric Department of the National Physical Laboratory, where routine measurements are now made with confidence and accuracy as a matter of course. At the same time the extension of the circle of workers in photometry has led to the introduction of many convenient forms of illumination-photometers which have done excellent service and contributed greatly to raising the status of photometry as a subject of practical importance. Amongst these may be mentioned the instrument introduced to the Illuminating Engineering Society about 16 years ago by Messrs. J. S. Dow and V. H. MacKinney, which, in spite of some improvements and modifications in design, still remains the same in principle, and is regarded as one of the standard instruments in use to-day.

Advances in the precision of photometry have been accompanied by a recognition of its many and varied applications. Apart from the routine testing of lamps, photometry is playing a part in the solution of many varied problems, a detailed list of which was given in Mr. Buckley's paper. During the war it was used for testing both the candle-power of flares and the brightness of luminous paint, representing the extreme variations of candle-power ordinarily met with. It is being used for such varied purposes as the study of the stars, access of daylight into buildings, the design of picture galleries, the relation between illumination and efficiency of fine work, the effects of glare, the qualities of road surfaces and the nature of artificial daylight. It has yielded us priceless information on the lighting of streets, schools, factories, shops, etc., and enabled us to form estimates of the illumination needed for various purposes. It has paved the way for the stage we are now reaching—the period of standardization, as illustrated in the work of the British Engineering Standards Association, which has now taken illuminating engineering within its scope.

One of the first results of the work of the various B.E.S.A. Committees was the issue of the Standard

Specification on Portable Photometers, discussed before the Illuminating Engineering Society last year. For the first time the requirements of a precision instrument of this type were accurately stated, in itself a significant illustration of the advance that has taken place. Already different grades of portable photometers are recognized. For certain work, involving the fulfilment of contracts, instruments of the precision class are necessary, and the maintenance of accuracy may involve some additional complexity. On the other hand there is room for instruments intended mainly for demonstrations and for practical experimental work where the need for accuracy is not quite so stringent. But whatever the form of instrument employed care must be taken that it is systematically checked, a process that can now be done very readily, and that the order of accuracy attainable used is well within that imposed by regulations or other conditions applying to the installation tested.

There is no doubt that the wider use of portable photometers has been one of the most influential factors in rendering photometry a more familiar process. Fortunately, we have now quite a wide circle of people who are conversant with the use of photometric instruments and apply them habitually. But we would like to take this opportunity of expressing our appreciation of the great services which the National Physical Laboratory has rendered to the advance of photometry, and the good work which Dr. Rayner, Mr. C. C. Paterson, Mr. Walsh, Mr. Buckley and others have done in this field.

## Luminous Traffic Signals

THE rapid progress being made in the United States in the application of light to the guidance of traffic is illustrated in a readable booklet which we have received from the Edison Lamp Works. Mr. G. F. Prideaux contributes some striking statistics of the advantages of such signal lights. The National Automobile Chamber of Commerce recently conducted a survey on the effect of signal lights on traffic accidents. Twenty-nine of the cities approached believe that their use has contributed to the diminution of accidents, and twenty-six reported that they had rendered possible an increased volume of traffic.

The applications of light in this way assume many different forms. One of the simplest devices, which might with advantage be copied in other countries, is the installation of a concentrating unit at important crossings so as to "floodlight" the officer on duty and enable drivers to see his signals easily.

The most widely used devices are clusters of coloured traffic signals operated from a central control station. Such units are equipped with colour-screens and lenses, and usually also with screens preventing their being seen by others than those in the approaching stream of traffic. The possible application of such devices in European cities has raised much discussion

Yet another device is the "traffic flow guide," which may take the form of a "mushroom," or dome, mounted on the roadway in the middle of the street. These devices are illuminated by lamps below, and may serve to direct vehicles to the right or left or merely as a caution to drive slowly. They are substantially built so as to withstand accidental collision, and are also being adopted in some cities in Germany. Evidently the design of traffic lights has already become a specialized field of illuminating engineering, which deserves the attention of authorities in this country.

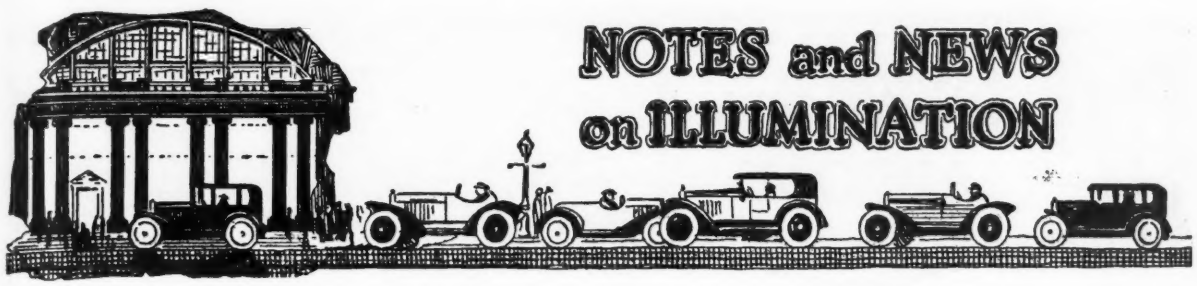
## Improvements in Miners' Lamps

WE have received from Dr. H. M. Vernon, who is one of the investigators for the Industrial Fatigue Research Board, a reprint of a series of informative articles recently contributed by him to *The Colliery Guardian* on the improvement of miners' lamps. This problem has frequently been discussed before meetings of the Illuminating Engineering Society, when the extremely low-working illumination afforded by the average miner's lamp was emphasized. With a lamp giving, in general, not more than 1 candle-power suspended in the usual way about six feet from the coal face, the illumination can hardly be more than 0.14 foot-candle, and less than a tenth of even this feeble light is reflected from the black surface of the coal.

The desirability of any steps that will improve the candle-power of lamps is therefore manifest. Dr. Vernon draws attention to one simple and obvious step—the proper selection of electric lamp bulbs. At present, he remarks, the selection of bulbs is more or less a matter of chance. Colliery managers require guidance in the selection of efficient types, and should reject inferior ones even if apparently cheap. But there is also great scope for variation in the efficiency at which lamps are run. Five different grades tested by Dr. Vernon showed an extreme range of 0.41 to 1.10 candles. The higher candle-power was probably obtained at some natural sacrifice of life. But we believe that in view of the low cost of bulbs in relation to the advantage of getting more light it would be well worth while to aim at the higher grade of efficiency and discourage the use of lamps that last a long time merely because they are under-run.

Attention is next drawn to the irregularities in distribution of light from lamps, and the improvement in all-round luminous intensity effected by the use of metal reflectors or specially designed well-tops. By this means the illumination in the direction of work can be increased quite 40 per cent. Finally, there is the problem of reduction of glare. The incandescent filament, even of a miniature lamp, is an intensely bright object in the darkness of the mine. The fact that exposure of such filaments to the eye does cause "glare" is illustrated by data on the production of after-images. These after-images, besides being indicative of visual fatigue, materially affect the efficiency of work. It was shown, for instance, by an ingenious target-pricking device, that the accuracy of aim is diminished. After looking at a 3.4 candle-power lamp for one second at a distance of two feet the average error was increased 33 per cent. Miners unconsciously look obliquely at their lamps, but they cannot avoid occasional glimpses of the filament—this applies particularly to fillers, who often use their lamps only 1 to 1½ feet away from their eyes.

The simplest precaution against glare is the frosting of the bulb—a device which is now becoming general in the case of lamps used for ordinary purposes of lighting, though hitherto only rarely used for miners' lamps. The total diminution of light is estimated not to exceed 8 to 17 per cent., but, owing to the improved distribution, the practical working illumination is not much affected. On the other hand, the relief of glare and the resultant formation of softer shadows are distinct advantages. We commend Dr. Vernon's investigation to readers as a useful contribution to the study of this difficult subject.




## Progress in Photometry

The paper read by Mr. H. Buckley at the last meeting of the Illuminating Engineering Society, held at the National Physical Laboratory on April 26th, contained an admirable review of the work of the Photometry Section of the N.P.L. Another very able survey of recent developments was included in the series of three Cantor lectures on Photometry, delivered by Mr. J. W. T. Walsh before the Royal Society of Arts last month. The lectures were very lucidly delivered and illustrated by numerous experiments. The good attendance at these lectures afforded a striking illustration of the growth of interest in this subject since the Illuminating Engineering Society commenced its work 18 years ago.

## National Association of Supervising Electricians

CHANGE OF NAME.

As and from April 1st, 1927, the new name of the above association will be the Association of Supervising Electrical Engineers. The new name will more nearly reflect the qualifications and experience of the members and their duties, while it is generally agreed that the designation "Electrician" as used in the early days has lost its significance.

New rules will also operate from April 1st, under which the qualifications for membership have been strengthened, the number of years' experience for supervising and commercial engineers and foremen being increased, in the former case to ten years and in the latter case to eight years, with minimum ages of 26 and 24 years respectively. Subscriptions are reduced, and will include the association's monthly journal. The address of the association and telephone number remain the same.

## Light and Health

The importance now attached to light in relation to health and disease is illustrated by the series of four lectures on "Sunlight and Health," arranged by the People's League of Health and delivered in the lecture room of the Medical Society of London during this month. The first lecture on "The Sun and its Health-giving Properties" was delivered by Professor Leonard Hill on May 12th. This subject also figured on the programme of the Hospital and Institutions Exhibition and Conference, which has just taken place at the Royal Horticultural Hall, Westminster. The exhibition received influential support, an enterprising feature being the organization of a technical committee on which the Illuminating Engineering Society was represented.

## American Röntgen Ray Society

TWENTY-EIGHTH ANNUAL MEETING.

The twenty-eighth annual meeting of the American Röntgen Ray Society will be held in Montreal on September 20th to 23rd, 1927, under the presidency of Dr. A. Howard Pirie, of Montreal. This is the first occasion on which the Society has met outside the United States; and, to acknowledge the honour paid to a British radiologist by his election to the presidency of the Society, a party of radiologists from this country are proceeding to Montreal in September to take part in the proceedings. Dr. G. W. C. Kaye has been invited by the Society to give the Caldwell lecture.

## The Lighting of Bevis Marks Synagogue

It is reported that the famous Bevis Marks Synagogue, the oldest in England, is considering the installation of electric lighting. Up to the present time wax candles, arranged in tiers on the historic chandeliers of Dutch design, have been used. We recall that in one of the very early issues of this journal (January, 1909) an illustration showing this method of lighting was presented. It was mentioned at that time that the question of installing electric lighting had been discussed in connection with the bicentenary celebration of its foundation a few years earlier. On that occasion the authorities decided to retain the exact original arrangements, which are modelled on those of the celebrated Amsterdam Synagogue. Now, possibly, a change may be made.

## The Total Eclipse of the Sun

The total eclipse of the sun, which will be visible on June 29th, is, of course, a very rare event. It is over 200 years since the last total eclipse occurred in this country. The eclipse will only be "total" over a narrow band in the North of England. Several past eclipses, though none quite total, have been recorded in *The Illuminating Engineer*, and interesting records of the variation in daylight in the course of such eclipses have been published. The study of the light changes on this occasion, granted fine weather, should be particularly instructive, and we understand that special arrangements to obtain information on this point have been made. Whilst referring to this subject we may mention a timely lecture on the coming total eclipse by the Rev. T. E. R. Phillips, given at the Polytechnic, Regent Street, on May 27th—a characteristic enterprising effort on the part of the Polytechnic.

## B.E.S.A. Specifications

We have received from the British Engineering Standards Association copies of two new specifications relating to instrument transformers (No. 81, 1927) and graphic (recording) ammeters, voltmeters and wattmeters (No. 90, 1927). Copies of these specifications (post free 2s. 2d. each) are available on application to the British Engineering Standards Association, 28, Victoria Street, London, S.W.

## Illuminating Engineering Society

(Founded in London, 1909).

GENERAL MEETING.

A *Joint Meeting* with the Joint Industrial Council of the Printing Trades of the United Kingdom will be held in the Court Room at the Stationers' Hall, London, E.C.4 (off Ludgate Hill), at *6 p.m.* on *Tuesday, June 14th, 1927*, when a discussion on "*The Relation between Illumination and Fine Work*, with Special Reference to the *Lighting of Printing Works*," will be opened by Mr. H. C. WESTON (Investigator to the Industrial Fatigue Research Board and the Illumination Research Committee).

ANNUAL MEETING.

The *Annual Meeting* will be held at *4 p.m.* on *Tuesday, June 21st*; further particulars will be announced in due course.

## German Illuminating Engineering Society

VISIT TO THE "PLANETARIUM" IN BERLIN.

The German Illuminating Engineering Society is evidently taking a broad view of its interests, as was shown by the programme arranged for a recent meeting on May 14th. The feature on this occasion was a visit to the Berlin "Planetarium," supplemented by a descriptive astronomical lecture by Dr. R. Wegner. Readers may be reminded that the planetarium is a highly ingenious apparatus for reproducing the appearance of the sky and the motions of the sun, moon, planets and stars. The exhibit of this remarkable piece of apparatus at the Gesolei Exhibition at Düsseldorf attracted much public interest, and the hope has been expressed that London may acquire a planetarium. Following the meeting an excursion to Potsdam was planned, agreeably combining instruction and pleasure.

## Electrical Developments in Holland

The proceedings of the Dutch Association of Electrical Trades and Industries, which was held in Utrecht during March 15th–18th, suggest that electrical developments in Holland are being actively promoted. The inaugural address of the President (Mr. Bellaer Spruyt) emphasized the great possibilities of electrification and the need for co-operation between all sections of the industry. Professor Ornstein, of Utrecht University, read a paper illustrating the benefits of a mutual understanding between engineers and centres of scientific research; Dr. Lulofs, Manager of the Amsterdam Municipal Power Station, referred to various special applications of electricity; for example, in the sterilization of milk, heating of school classrooms, and heat storage for hot-water supply. We are interested to see that illumination was not overlooked. M. Baart de la Faillie and Dr. N. Halbertsma presented a joint paper on the electric home, and short communications dealing, amongst other matters, with illumination photometers were presented. At the banquet Mr. A. F. Philips announced a new success on the part of the staff of his radio research laboratory—the transmission of speech and music to the Dutch East Indies and Australia by short-wave broadcasting without beam effect. Simultaneously with the meeting there was a joint exhibit by 25 electrical firms at the Utrecht Fair.

## More Experiments in Television

The recent issue of the prospectus of a public company to develop television in this country is an indication that the practical possibilities of this idea have been brought appreciably nearer. We notice in *The Electrical World* an account of a public demonstration given on April 7th by the American Telephone and Telegraph Company. In Washington, Mr. Hoover, the Secretary of Commerce, spoke to a company of 70 invited guests assembled in the laboratories of the company in New York. Mr. Hoover's face was seen by television while he talked, his words being simultaneously transmitted by wireless. The reproduction of the face on the small 2 in. by 3 in. screen was considered very successful, though the effect on a larger screen (2 ft. by 3 ft.) was not so good. The apparatus was explained by Dr. H. E. Ives, who pointed out that the essential feature of the process was the use of a "scanning" method, by which each element of detail was seen in rapid succession, the whole process taking only 1-15th of a second. The photo-electric cell constructed for this work is probably the largest in the world. For the receiving lamp a neon lamp is used, this lamp having the valuable feature that it acts instantaneously, whilst the brightness is proportional to the potential applied. In spite of the apparently successful results obtained on this occasion, it is stated that the officials of the company are not very sanguine about the immediate commercial exploitation of the idea owing to the heavy expense of installation.

## Visibility in Street Lighting

A contribution by Messrs. Preston S. Millar and S. McK. Gray in *The Electrical World* describes a modification of their existing variable contrast-testing device, applied to determine the effect of glare in street lighting. This utilizes an 8-inch aperture having a diametric bar of variable width at an adjustable inclination. In practice the width is reduced to its minimum (about $\frac{1}{4}$ inch), and it is then gradually increased by motor control by the observer, stationed perhaps 150 feet away, until the stage of maximum perceptibility is reached. The bar may be of any colour, but in general should resemble that of the street surface. Originally a reflection factor of 14 per cent. was adopted for the bar, and the reflection factor of the ring forming the periphery of the aperture should be about the same. As mentioned above, the width of the bar can be adjusted, but the simplest means of varying the range is by altering the distance of observation. In the original article a curve relating the width of the test bar to the illumination in foot-candles on the face of the test object is presented.

It is believed that the apparatus will prove very useful in testing visibility and the effects of glare in street lighting.

## Light as an Aid to Aerial Navigation

In view of the very informative paper on the above subject, contributed by Mr. H. N. Green to the Illuminating Engineering Society, which was concluded in our last issue, it is of interest to observe a discussion on lighting appliances opened by M. Marsat before the Société Française des Electriciens, in the course of which several novel lighting appliances were described. One of the most interesting of these comprised two projectors mounted above a self-contained generating set, and capable of being moved from place to place as a trailer attached to a light tractor-car. Col. Renard, of the French Aero Club, who took part in the discussion, recalled that when aviation began it was generally assumed that no one would attempt to fly by night—an expectation that was not disparaging to aviators, seeing that the great majority of birds only fly by day. M. Franck raised the debatable question whether it is better to mark out a course by a large number of beacons of moderate power or a few very powerful ones. He remarked that the lighting at Croydon is considerably more powerful than that at Bourget, but was inclined to doubt whether excess of light might not prove an actual drawback during periods of fog.

# TECHNICAL SECTION

COMPRISING

Transactions of The Illuminating Engineering Society and Special Articles

*The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.*

## Some Problems in Illuminating Engineering

*(Proceedings at the meeting of the Illuminating Engineering Society, held at the E.L.M.A. Lighting Service Bureau, 15, Savoy Street, London, W.C., at 6-30 p.m., on Tuesday, March 22nd, 1927)*

IN our last issue we gave a brief account of the meeting of the Illuminating Engineering Society held at the E.L.M.A. Lighting Service Bureau on March 22nd. At this meeting a new departure was followed. Instead of the whole evening being given up to the discussion of a single paper, a series of problems in illuminating engineering was presented by different authors, each of whom described how the problem had been dealt with in their experience.

In what follows we give a detailed account of the introductory statements of problems, and the ensuing discussion. The first item on the programme was a description by Mr. L. M. TYE of a novel scheme of decorative lighting, carried out in the Greyhound Theatre and Dance Hall at Croydon.

### The Lighting of the Greyhound Theatre and Dance Hall, Croydon

By L. M. TYE

The old "Greyhound," in the High Street, Croydon, which is of considerable historic interest, has recently been transformed into the new Greyhound Theatre and Hotel, and is possibly the only fully licensed house, restaurant and hotel combined, in Great Britain which has also a licence for performing plays, and is thoroughly equipped as a theatre.

The new hall, which will comfortably seat 600 people, is shown in Fig. 1. A change-over from a theatre to a ballroom can be effected in 15 minutes. The architect, Mr. H. Macintosh, F.R.I.B.A., has devised a new panelled partition between the new interior and the old banqueting hall, so that, if desired, simultaneous entertainments, each inaudible to occupants of the other room, can take place. Diners may also, on occasion, become part of the audience.

FIG. 1.—The New Greyhound Theatre and Dance Hall, Croydon.

The lighting of the interior was therefore required to be at once decorative and flexible. Cabaret entertainments, dancing or cinema shows may also take place. Lighting for all purposes must be provided, and both white and coloured effects are essential. The hall is conveniently divided into two portions; the centre, approximately 40 feet square, and the rear portion 40 feet wide and 22 feet deep. In the centre the surroundings are light in character, and it was accordingly decided to utilize indirect lighting for the general white illumination, supplemented by variable colour lighting. An inverted central fitting exceeding five feet in diameter was therefore installed. In the top of the fitting six Holophane projector units were mounted, each equipped with a 300-watt gasfilled lamp. The positions were so adjusted that the light rays terminated at a point level with the cornice. The resultant diffused illumination gave quite satisfactory effects, as the photograph (Fig. 1) suggests. The illumination averages over 4 foot-candles for an energy consumption of approximately 1.2 watts per square foot of floor area.

This centre fitting is relatively shallow, and comprises 12 panels of triangular shape running from the outer band to the lower rim. Six of these panels are large, the others small. In the six principal sides are arranged special 12 in. Holophane refracting plates, and in the smaller ones corresponding plates are also mounted. The intervening spaces are filled up with stippled glass with colours merging from amber and red to blue. In the case of the fitting a 16 in. Holophane hemisphere is mounted.

The arrangement of the colour lighting is as follows: The six 12 in. refracting plates have behind them the special Holophane colour equipment enclosed in an opaque reflector unit. The colour effects produced on these plates are therefore entirely independent and distinct from the changes which can be brought about in the other parts of the fitting, and they will furnish the necessary subdued light during the progress of a show.

In the lower bowl a 300-watt amber lamp is provided. In the remaining part of the fitting there is a battery of amber, red and blue lamps, all on different circuits, so that the whole body of the assembly can be built up in colour with most striking effect, and in distinct contrast to the special colour produced by the refracting plates themselves. The same principle has been applied to the fitting which serves the rear part of the hall, excepting that in this case the projector units are dispensed with, the fitting being brought close up to the ceiling. Additional decorative lighting for the hall is effected by wall brackets of flambeau design arranged along the side walls. Cartouche lighting is also arranged in cornice with lamps of red, amber and blue. A view showing the lighting of the Restaurant is presented in Fig. 2.

The stage lighting has been effected by the new Holophane prismatic footlights and proscenium battens. The former follows the contour of an apron stage, and comprises 30 reflector units. Eight of these are arranged for red lighting, eight for blue, and 14 for white. The stage batten has 28 reflector units—seven arranged for red lighting, seven for blue, and 14 for white. A special batten is provided outside the proscenium for special settings, and is made up of 20 units—eight white, six red and six blue. Spotlights are also available. The whole of these are controlled by a switchboard at the side of the stage.

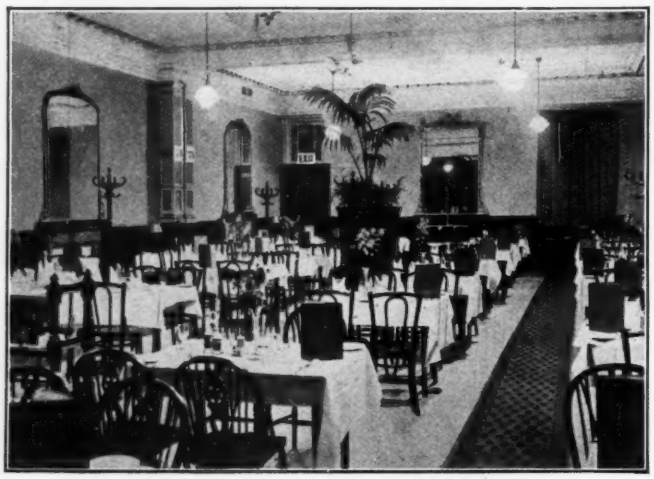


FIG. 2.—One of the Restaurants of the Greyhound Hotel, Croydon, equipped with Holophane Reflector Refractor Units.

The design and special lighting arrangements in this unique building have attracted much public attention, and they have been referred to in several London papers. A canopy is about to be erected over the High Street entrance to the theatre, for which a special system of coloured lighting is at the moment being devised. This is being arranged on a motor-driven controller, so that the colours are continually changing.

The results clearly illustrate the advantages to be derived by close co-operation between the lighting engineer, architect and electrical contractor, as has been possible in this case with such striking success.

Our thanks are due to Mr. Hugh Macintosh for the reduced-size drawings and perspective sketch which he has prepared specially for our meeting to-night. I should also not like to pass without a word of admiration of the work of the electrical contractor, Mr. F. Wingfield, who, in addition to the theatre and stage electrical work, has been responsible for the whole hotel installation.

Following Mr. Tye's communication, Mr. H. H. LONG dealt with another unusual lighting installation, the artificial lighting of a greyhound racing track.

## The Lighting of a Greyhound Racing Track

By H. H. LONG

In introducing this subject Mr. Long explained the nature of these special racing tracks, which are now becoming quite a popular form of sport. The special feature is that the hounds chase an "artificial hare," which is a model driven electrically round the track, the speed of which can be regulated. Artificial lighting, enabling races to take place at night, is an obvious advantage, but the problem presents certain difficulties. Essentially the problem involves the provision of a high intensity of illumination on the track itself, and as little light as possible should be "spilled" over the sides.

Two alternative methods of providing this illumination suggest themselves. The track may be lighted either from above or by means of units mounted at the side at a low level. No obstructions are permissible on the track. Therefore, if lighting from above is attempted, the poles carrying the lighting units must be placed at the sides of the track. Poles on the outer side would be open to the objection that they would obstruct the view of spectators. On the other hand, if they are situated on the inner side of the track there is a danger of glare in the eyes of the spectators. Moreover, a large number of units would be necessary.

If, instead of this, narrow beam projectors are mounted at a low level along the outer edge of the track a much smaller number of units will suffice, as each projector will cover a greater distance, and the objections mentioned above are avoided.

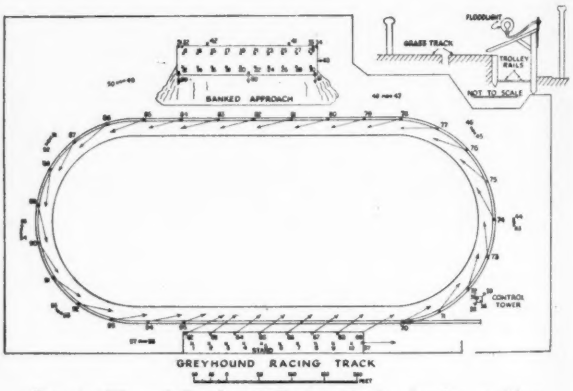



FIG. 3.—View of Greyhound Racing Track, showing positions of Projectors.

In the case of the track under consideration this method was adopted: "Emvee" Perchromia plated projectors are mounted over the centre of the railway roof at a height of about three feet from the ground. The beam is slightly depressed and projected inwards to the centre line of the track in the direction of the racing. As an additional safeguard against glare, shields are fitted to the projectors.

This system has proved quite satisfactory in practice. Fig. 4 shows a view of the projectors employed, and Fig. 3 is a plan of the track, on which the positions of projectors and the method by which their light is directed is seen.

FIG. 4.—A View of one of the Projectors used.

Mr. W. MILLNER then described an unusual and interesting case of cornice lighting.

## The Lighting of St. Sophia Cathedral

By W. MILLNER

During the early part of last year the question of relighting the Cathedral of St. Sophia, St. Petersburgh Place, was up for consideration, and it was my privilege to co-operate with the consulting engineers, Messrs. Lucas & Pyke, in the preparation of a scheme of concealed lighting. The building is almost unique in this country, and consists essentially of a large mosaic dome 42 feet in diameter, which entirely covers the whole of the central area. At the base of this dome is a heavy cornice, from which it was proposed that the lighting should be effected.

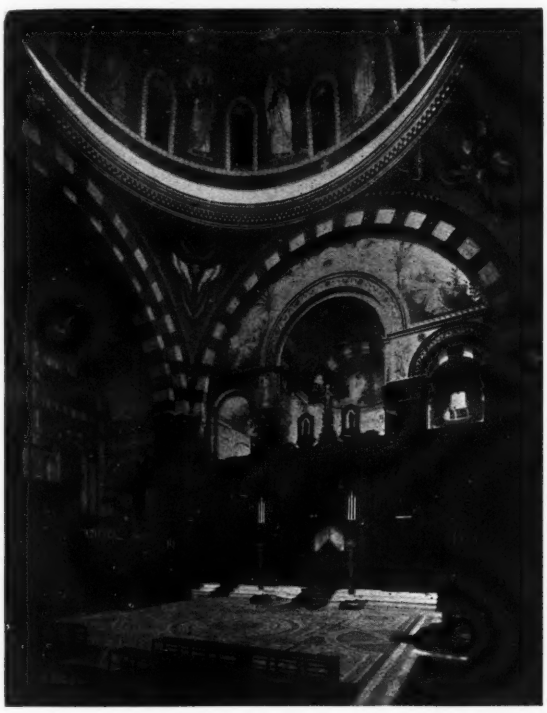


FIG. 5.—Cathedral of St. Sophia, London. Trough Reflectors in Dome. Angle Reflectors behind Screen.

In preparing the scheme, one of the chief difficulties was the estimation of the total wattage required to give satisfactory effects in service, as owing to the height of the dome, approximately 80 feet above the floor level, cleaning is a matter of some difficulty, and can only be undertaken over long periods. During last year the whole of the interior was renovated, and whilst the scaffolding was in position the lighting equipment was installed.

The interior of the dome is predominatingly gold in colour, with mosaic figures around the lower edge and also in the centre. In view of the rapid deterioration of the reflecting surface of this dome, owing to the collection of dirt and dust, and also owing to its low reflection factor, a high ratio of watts per square foot of area to be lighted was required. Eventually it was decided to install 72 300-watt gasfilled lamps, equally spaced around the cornice. A special trough reflector was constructed, which was fixed rigidly to the cornice.

FIG. 6.—Cathedral of St. Sophia, London. A special view of the Illuminated Dome.

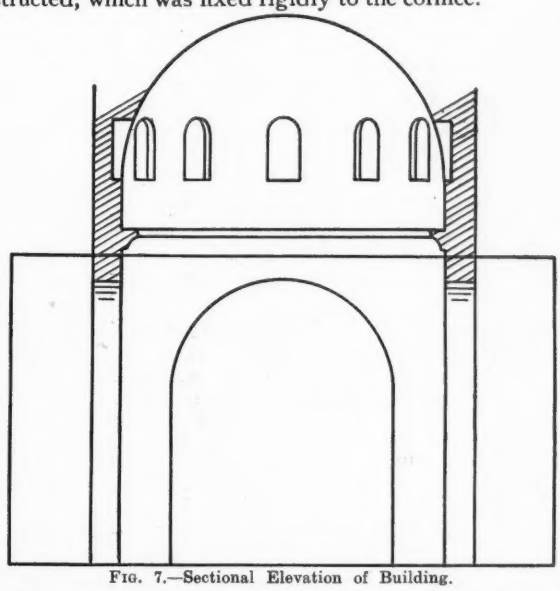


FIG. 7.—Sectional Elevation of Building.

For maintenance the only access is through the windows, the sills of which are 6 feet above the cornice. For this reason the lamps were carried in groups of six, three on either side of a hinged centre point fixed to a two-pin plug. A socket was recessed into the cornice, and by this means it is possible by leaning through the window from the outside to insert the plug into the socket, and then allow the lamps and their supports to fall into position on the reflectors.

The whole of the main lighting is controlled by a regulating transformer, allowing various intensities of light to be obtained. The effect, when the installation is switched on at a low intensity and gradually increased to its maximum intensity, is singularly beautiful. Owing to the golden colour of the dome, the light has a warm yellow shade, very reminiscent of sunlight.

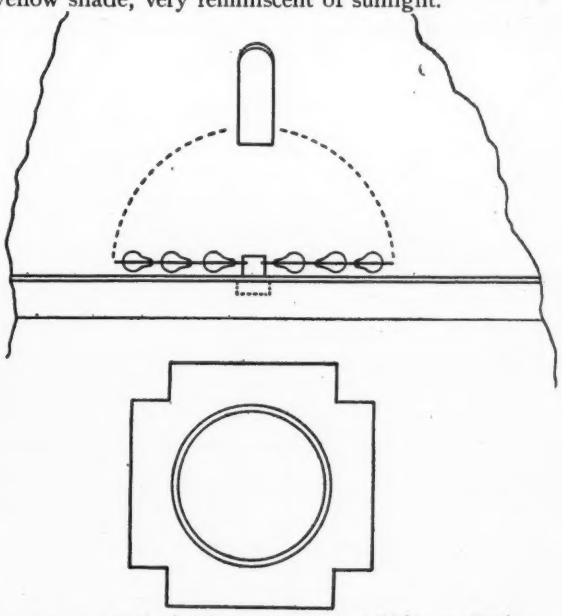


FIG. 8.—Sketch showing Arrangement of Lights on Cornice.

The attached photographs give some idea of the effectiveness of the installation, which was carried out by F. H. Wheeler & Co., Victoria Street, S.W., under the direction of the consulting engineers, Messrs. Lucas and Pyke.

## Two Problems in the Colour Lighting of Show Windows

By L. E. BUCKELL

Mr. L. E. BUCKELL then referred to two problems in connection with the colour lighting of show windows, which had come before his notice in the course of his travels round England. The first problem related to a window about 15 feet square, which was a corner window visible from two sides. An effort had been made to apply colour lighting to this window, which was devoted to the display of furniture. The result was considered flat and uninteresting, and was not satisfactory. Originally 24 reflectors, each equipped with 150-watt lamps, had been used. Colour screens of somewhat crude red, green, amber and blue were used, five lamps being filled with each colour and four left white. The various colours were controlled by a flasher.

Investigation showed that the flat appearance was due to the following causes:—

(1) The reflectors employed were not efficient and unsuitable for the work.

(2) They were mounted higher than was necessary, and were not distributing their light in the right direction.

(3) The colour gelatines employed were not those best suited to show up the goods in the window to the best advantage.

(4) The rotation of colours on the flasher was not well designed, and the changes took place rather too quickly. As a result of experiments it was found that twelve reflectors of different design, having a more appropriate distribution curve, gave very much better illumination than when the colour changes were confined to two or three only, these colours being selected with due regard to the goods to be lighted up.

As a result of these changes the effect was quite satisfactory.

The other problem discussed again related to a shop in which furniture was displayed. The furniture consisted chiefly of dark mahogany or rosewood, with leather upholstery. The window had been lighted by well-designed reflectors put in the correct position and fitted with colour screens of a clear gold and yellow. The result was most striking, and arrested the attention of passers-by.

## Platform-Lighting on a Suburban Station

By A. CUNNINGTON

Mr. J. S. DOW said that he had recently visited a suburban railway station with Mr. A. Cunnington, the lighting engineer of the Southern Railway, where an interesting problem had arisen. Mr. Cunnington had hoped himself to be present and describe the conditions, but had been prevented from doing so by a prior engagement, and had asked him (Mr. Dow) to present the problem.

This station was formerly lighted by gas mantles in clear globes. Many stations were lighted by similar methods without any objection being taken to the exposure of the mantles, which were of moderate brightness. But in this particular instance it happened that the line of exposed lights down the platform interfered materially with the inspection of the signals at the far extremity of the platform; consequently drivers were handicapped owing to inability to distinguish the signals in time.

This had been traced to the glaring effect of the row of exposed lights. The lights on the platform in question had now been converted, the mantles being screened by a suitable enamelled-iron reflector. From the stance of the driver on his engine it was now practically impossible to see an exposed mantle, and the difficulty in seeing the signals which, being covered by coloured glasses, were of relatively low luminosity, had been completely overcome.

## Problems in Light Projection

By J. S. DOW

Mr. J. S. DOW then proceeded to bring before members a problem which seemed to deserve special study by illuminating engineers. In the case of most practical applications of artificial light the utilization efficiency was reasonably high, and the scope for possible improvement in this respect was not very great. But in one case, the projection of luminous pictures by lanterns and kinema apparatus, the efficiency was still exceedingly low. It had been stated that in the average kinema theatre the percentage of the light yielded by the source which was actually usefully applied on the screen was not more than 5 per cent., and he believed in some cases 1 per cent. would be nearer the mark. When it was recalled that, of the light received by the screen, only a moderate proportion reached the eyes of the audience—a varying fraction being reflected in the direction of walls, ceiling, etc.—it would be seen that this was a case of very low efficiency.

A certain amount of light was necessarily lost in passage through the optical system of the projector, but the dominant explanation of the poor efficiency was the difficulty in bringing any substantial portion of the original light on to the objective lens. Owing to the danger of cracking the condenser by heat an arc (in itself a very suitable source for optical projection) could not be brought very near to this lens, so that the proportion of light reaching it was small. Electrical incandescent lamps of relatively small consumption and emitting less heat, appeared more suitable from this standpoint. But the difficulty in the case of this source was that the filament was not a " point," and even when the filament was specially wound in a small compass the source was not optically continuous. Spiralized filaments had, how- been wound as small as possible, and as such lamps could be brought nearer the projector the efficiency could be materially improved.

Another important means of improvement was the use of a concave mirror behind the filament, so as to reflect on to the condenser light which was otherwise wasted. The most suitable arrangement was to place the filament at the focus of the reflector so that the image of the individual elements could be made to fill the gaps in the actual filament, thus producing what was in effect a continuous source. In Germany a novel step had been the mounting of small spherical reflectors, *inside* the lamp and very close to the filament. This had the advantage that the correct distance between filament and reflector was definitely fixed; and it was unnecessary for the operator to make trials of the best positions when a new lamp was substituted for an old one. The use of a reflector in very close proximity to the filament was also favourable to collection of a maximum proportion of the original flux of light. It would appear, however, that the power of resistance of the metallic mirror to the heat of the filament would require study.

Mr. Dow also illustrated several recent minor improvements, such as the use of a supplementary mirror between the source and the film, which appeared to improve the efficiency. In spite of these advantages incandescent electric lamps were still rarely used for projecting pictures in large halls, though they had useful applications in rooms of moderate size. He thought that the chief reason for this was that success in this problem was not merely a matter of efficiency. The essential point was to obtain a sufficiently bright picture, and this depended primarily on the intrinsic brilliancy of the source rather than its candle-power. The higher intrinsic brilliancy of the arc, as compared with the filament, was thus a vital advantage. Unfortunately it did not look at present as though the brightness of the tungsten filament could be very substantially increased; though by over-running a stout filament an improvement could be made, and in the " Pointolite " and similar lamps using a tungsten arc higher intrinsic brilliancies could be obtained—yet still far less than that of the arc between carbon electrodes.

This led to the interesting question, " Is it possible by any practical optical device to produce an image brighter than the original source? " It would be observed that

this did not involve any *creation* of light, for the image might be very much smaller than the original source. One might, for instance, collect the light from a surface as great as the wall of a room, on which the light was directed, and bring the rays down to an image of a few square millimetres, and the total flux of light might then be very much less than the original flux, though the brightness was greater.

One could think of many cases in which such a process would be useful—for example, in the photometry of very feebly luminous surfaces. So far as he (Mr. Dow) could ascertain, this process could not be realized in practice; but he was not sure whether there was any fundamental theoretical reason why this should be so.

## Discussion

Mr. W. E. BUSH remarked that the meeting was in the nature of an experiment. He thought that it should be considered an outstanding success. The problems had each been presented in a concise form and hints for their solution given. He hoped that the experiment would be repeated. Several of the installations were very interesting in showing the skilful manner in which artificial light could now be applied. There might be some architects who still considered illuminating engineering a joke, but he felt sure that if they had heard the descriptions of the striking installations presented at this meeting they would have to admit that illuminating engineering had some brains behind it. Descriptions of successful lighting installations of this nature were very valuable. The more they could be brought to the notice of the world in general the greater would be the recognition of the value of the work that lighting experts could perform.

He entirely agreed with the remarks Mr. Buckell had made about the use of crude colours. Really artistic displays could not be contrived by working with primary red, blue, green or yellow. He thought that manufacturers should aim at presenting a greater variety of tints.

Mr. W. C. RAFFÉ said that the use of colour in shop-window lighting had always struck him as being to a certain extent analogous to poster and stage lighting. It was not a question merely of the variety of light used, but also of forms, surfaces and textures. The use of muslin for diffusing light was a simple but effective method. Whistler used to drape the windows of his studio with curtains of butter muslin, with the object of shedding a diffused light on his sitters. It must not be overlooked that the change in intensity produced by the action of dimmers had an appreciable effect on the colours. One of the chief difficulties in applying coloured light was the effect of the light on the coloured medium. He had been experimenting with an entirely new paint having a silica basis. This had shown satisfactory permanence with opaque colours, and if equally good results could be obtained with transparent colours it should prove very serviceable, as it would withstand practically any heat.

It was unfortunately true, as Mr. Bush had said, that many architects did not take illuminating engineering seriously. The same might be said of their attitude towards decorative problems. It was difficult to get people to appreciate the apparent change in form caused by lighting from below, instead of from above. Although architects were now becoming familiar with the floodlighting of a building from the first floor, they were still sometimes startled by the appearance of the shadows. In two of the installations described that evening, the lighting of the racing track and the illumination of the cathedral, floodlighting from selected points was used.

As regards the utility of coloured lighting, shopkeepers should be shown that by using carefully selected coloured light the appearance of their goods might be improved. On the other hand, the indiscriminate use of crude colour might have anything but a beneficial effect. A confectioner would not improve the appearance of the things he offered by using a light with too strong a rose or green tint. People's views of food were affected by its traditional appearance. He (Mr. Raffé) had been given white butter abroad. But in this country we were used to yellow butter, and somehow it seemed to taste better. Merchants should therefore guard against destroying the natural appearance of food by using the wrong form of light or a bad background.

Mr. S. G. ELLIOTT expressed his interest in the problems introduced which had apparently been successfully solved. He had, however, encountered a few which had up to the moment not been satisfactorily solved, and noped to have the views of members on them. One instance was the effective lighting of the interior (from the exterior) of a railway coach when undergoing repair work in a workshop, and being in continuous but slow motion. Another instance was a method of wiring in offices which would allow of quick and economical alterations to the lighting necessitated by staff movements, whereby a given area may be occupied at different times for long periods by, say, one person or many persons, such as typists, clerks, draughtsmen, etc., and bearing in mind that the area of the office may be increased or reduced by partitions; the rearrangement to be always left as a finished job with no loose wires, and leaving no unsightly marks on the ceiling. The most successful means so far employed by him was to panel the ceiling with wood casing.

Another problem was the lighting of escalators or moving stairways. It is essential that the lamps should be screened from the eyes of persons descending, and this has been met by providing plaster screens. These screens, however, have not a pleasing appearance, and experiments were now being made with indirect lighting.

The problem of floodlighting small enamelled-iron signs on railway bridges and elsewhere, when the nearest point on which fittings could be erected was some distance away, in one case 80 ft., had been successfully dealt with by using motor-car headlamps with 12-volt 36-watt bulbs, a step-down transformer being, of course, necessary; this method is most economical both as regards installation and running costs.

Mr. R. A. IVES expressed his appreciation of the very interesting subjects which had been introduced for discussion, and wished to support Mr. Herbert in congratulating the authors of the papers. The Council of the Illuminating Engineering Society were also to be congratulated on their enterprise in introducing this series of short complete papers. The authors of the papers each had a difficult lighting problem to solve, but each one demonstrated his method of solution in a most interesting, complete and scientific manner.

The account by Mr. Long of the illumination of greyhound racing tracks particularly interested him (Mr. Ives), because he had a somewhat similar problem in the lighting of a trotting track. This track was oval in shape, similar to the greyhound track, but of considerably larger dimensions. Various schemes were proposed, but a number of difficulties had to be met.

In the first scheme asymmetrical vitreous-enamelled steel reflectors were proposed; these were to be suitably slung on steel cables over the centre of the track. The reflectors were spaced to obtain a satisfactory illumination with freedom from glare and shadows, and they were also arranged to project the light in one direction only round the track, the object being to prevent the light source from being visible either to the competitor or the spectator.

On mature consideration, however, this scheme was not approved, because it was desired to use the track for trotting races in both directions, instead of one way round as at first proposed.

Therefore scheme No. 2 was prepared. In this scheme deep-bowl symmetrical vitreous-enamelled steel reflectors were specified, and were slung over the centre of the track and spaced to give a satisfactory diffusion of light, care again being taken to avoid glare and shadows.

But a difficulty again arose owing to the suggestion that any lighting fixture placed over the centre of the track, or even on standards arranged at the fences, would result in shadows being thrown on the track during sunlight which would cause the trotting horses to shy.

To overcome such shadows it would, therefore, be necessary to remove the fittings and supports during the daytime. Accordingly collapsible standards, which

could be lowered during the day, were proposed; but since there would be a large number of fittings the labour and time required would be a serious consideration.

A further specification, scheme No. 3, was then put forward; this again embodied asymmetrical reflectors, which were to be fixed on the inside fences of the track, being at a height even with the top of the fence on each side of the track.

This proposition, however, had its defects, since to prevent glare to the competitors and spectators alike it would be essential that the projected light beams should not throw too low—since only the lower part of the competitors might be illuminated—and not too high because it would cause glare to the spectators.

Suitable reflectors could be obtained which meet all the requirements for overcoming any of the defects mentioned, but, having been occupied with other matters, he had not been able to follow out to its logical conclusion the solution of this problem.

Summing up, however, it would appear that whatever form of lighting was finally adopted it must furnish light as perfectly diffused as possible in all directions over the track, with complete freedom from glare or shadow to competitor or spectator.

Mr. G. HERBERT referred to the lighting of island shop windows as a problem of some difficulty. Considerable skill was necessary in arranging the reflectors in such a way that the light did not shine into the eyes of people looking into the windows from any direction. In view of the immense progress made in illumination during the past century it was marvellous how workers in the past were able to do their task by such a feeble light. To illustrate this Mr. Herbert drew attention to the lighting conditions of bygone days illustrated in a cabinet of exhibits in the room, and also described a most interesting exhibit at the Ideal Home Exhibition, where three craftsmen were showing how their work used to be done. One of these workers was a flint knapper, another a wood turner. Both contended that they would rather work by the light of a candle flame than by the concentrated beam of a modern lighting unit. They seemed to work mainly by the feel of their tools, and a very low illumination sufficed.

Returning to the problem of lighting island windows, Mr. Herbert pointed out that goods were often situated very close to the glass, and were displayed right up to the ceiling. If concentrating units were mounted at the top of the window a spot effect was apt to be produced on the goods at the bottom, and the illumination in the centre of the window was weak. When looking upwards into the window the eye was apt to see the filaments of the lamps used. An arrangement involving the mounting of lights behind a ground-glass ceiling partially improved matters, but was not very efficient. One of the most successful methods of attacking the problem seemed to be to mount a deep trough practically all the way round. The trough was so shaped that a direct view of the light sources was prevented, and it was possible to illuminate evenly windows of very varied shapes.

Mr. Herbert also referred to the lighting of escalators, endorsing the necessity for screening of lights, and illustrated the difficulty in securing uniform illumination.

Mr. Herbert also mentioned that he had been instrumental in arranging the lighting of the gardens at the Ideal Home Exhibition, and he believed that the methods adopted were considered very satisfactory. The problem presented several special features. It was desirable to obtain (a) even intensity of illumination, (b) light sources well outside the direct range of vision (i.e., not falling within an angle of less than 30° with the normal direction of view), (c) ease of installation and manipulation of lighting units, and (d) a pleasing and cheerful effect.

The accompanying photograph (see page 171), which was taken entirely by artificial light at 10 p.m., showed the excellent result obtained. Even illumination was secured by using approximately 170 standard trough reflectors, with mirror-glass reflectors and opal screens, opal screens being also used to divide the units, each of which contained four 100-watt gasfilled lamps. The troughs, being fixed at the apex of the false roof, were completely outside the line of vision. The units were suspended on loops and drawn along wires fixed across each bay. They could thus be operated from convenient points and any replacements of lamps attended to without disturbing the exhibits or the visitors.

In conclusion, Mr. Herbert congratulated the authors on the trouble they had taken in collecting data for presentation at the meeting. He thought that it would be agreed that this novel departure had been justified, and no doubt meetings on similar lines would be arranged on other future occasions.

Mr. H. S. ALLPRESS remarked that the problem introduced by Mr. Dow was a very interesting one. He could not give a complete solution, but he thought it would be found that in practice no increase in brightness was attainable. In every case the loss incurred seemed to be greater than any apparent advantage secured. He himself, however, had recently had to deal with a projection problem that seemed to throw some light on the subject, namely, the adaptation of a kinematograph projector intended for demonstrations on a small scale. He had found that conditions were improved by using two condensers, the image from the first being formed at the focus of the second. Some degree of spherical aberration occurred, and this necessitated the use of a stop, which only eliminated the "aberrated" light. The whole arrangement rendered possible a beam of much smaller divergence than would otherwise have been obtained. The size of the source was in effect reduced, so that a more accurate focus was possible. He doubted, however, whether the overall efficiency of the apparatus was in any way increased. In such cases the main loss occurred at the first condenser.

Mr. Allpress also referred to the problem of glare as one requiring more detailed examination. The presence of definite glare reduced one's visual sensitivity, but it was sometimes a question whether this diminution was sufficient to affect the discrimination between light and dark. It was commonly assumed that glare was mainly dependent on the brightness of the object causing it; but he understood that when the source was of small dimensions—subtending less than 3° at the eye—the effect became essentially dependent on candle-power.

Several other speakers joined briefly in the discussion, in the course of which it was suggested that in many lighting problems the conventional shape of the lamp bulb was a drawback. For cornice lighting and many forms of concealed lighting it might be an advantage to use tubular lamps, which could be more easily screened. In the case of gasfilled lamps there should be no great difficulty in making cylindrical instead of pear-shaped bulbs.

The CHAIRMAN (Mr. A. Blok) agreed that the meeting had been a very successful one, and the Council would certainly bear in mind the undoubted desirability of repeating the experiment. The problems that had been put before them were real ones, and were not concerned only with matters of detail. One had a great admiration for those who were thus contributing to knowledge on illuminating engineering, and enabling the Society to fulfil its function of eliciting information.

Mr. Dow's contribution had illustrated how much remained to be done by illuminating engineers, but also how steady progress in detail was constantly being made even in the most difficult problems. Illuminating engineering might be said to be out of its swaddling clothes. With regard to the very handsome central fitting illustrated by Mr. Tye, he would like to know whether the effect was obtained merely by the use of fixed screens, and what measures had been taken to enable the fitting to be taken down for overhaul and maintenance. The installation described by Mr. Millner was in some respects unique. The treatment of such a lofty domed building was by no means simple. In this case also he would like to know how the reflector was cleaned. Mr. Long's account of the lighting of the greyhound racing track was very fascinating. He imagined that the dogs would run in a cluster, and wondered whether there was any trouble from shadows,

FIG. 9.—A View showing the Lighting of the Gardens at the Ideal Home Exhibition. (This photograph was taken by the unaided light of the fittings installed, and has not been retouched in any way.)

or, if there was, whether it could be cured by making the lamps throw their beams in alternate directions. With regard to Mr. Buckell's remarks he believed that by using gelatines practically any desired shade of colour could be obtained.

He had been interested to hear of the device used by Whistler for softening the light on his subjects. He recalled that an artist who was drawing a picture of him (the Chairman) on the slopes of Mount Carmel had thrown a piece of muslin fabric across the window because of the harshness of the sunlight. The effect was comforting to the sitter and no doubt of great assistance to the artist.

He agreed with Mr. Elliott that the practical problem of office lighting deserved consideration. As a rule, such premises had to be very economically lighted. Probably some sort of ring main, on the lines suggested by Mr. Elliott, would be useful in enabling the varied conditions arising from changes in positions of furniture, etc., to be met.

The authors of the papers subsequently replied briefly to points raised in the discussion. Mr. TYE explained that the colour equipment used in the large central chandelier comprised a special disc of glass sprayed with pure colour. The fittings were raised and lowered by a special winch of the drum type capable of dealing with 12 cwts. Mr. MILLNER stated that the cleaning of the reflectors in the Church of St. Sophia was done from the windows by means of a long-handled feather mop. The reflectors had clear surfaces, and could be cleaned very easily. If high-intensity general lighting was provided in an office the positions in which people sat did not greatly matter. Intensities of the order of 10 foot-candles were everyday working intensities and were fully justified. The additional running cost was counter-balanced by the fact that the existing wiring would answer all requirements, and did not have to be altered whenever a change in the room was made. Mr. L. E BUCKELL remarked that lamp makers recognized the utility of a long thin lamp for solving certain problems, but such lamps were difficult to make and were limited in application, and on the whole the bulb shape gave the best results. He agreed with the Chairman that a wide variety of colours could be obtained from gelatines. But there was a tendency for manufacturers to limit themselves to certain colours and to send them out in cases in which they were not suitable. He believed, however, that in the future something more suitable would be devised.

A vote of thanks moved by Mr. L. GASTER to the authors, to Mr. Blok for presiding, and to the E.L.M.A. Lighting Service Bureau for their hospitality, was carried by acclamation, and the meeting then terminated.

It was announced that, by kind invitation of the Director, a visit would be paid to the National Physical Laboratory on April 26th. An opportunity would be afforded of seeing the photometric laboratories, and a paper reviewing the work of the Photometric Section of the National Physical Laboratory would be read by Mr. H. Buckley.

# The Measurement of Light

A SERIES of three Cantor Lectures under the above title was delivered before the Royal Society of Arts by Mr. J. W. T. Walsh on April 25th, May 2nd and May 9th.

In the first lecture, delivered on the 25th April, Mr. Walsh gave a brief outline of the history of photometry, mentioning that the earliest workers in the subject were, not unnaturally, the astronomers. He said that the first photometric measurement, as we used the term to-day, was made by Pierre Bouguer on 23rd November, 1725, when he measured the illumination given by the full moon. After Bouguer, the great names in photometry were Lambert, who enumerated the fundamental laws of photometry; Rumford, who invented the first accurate photometer head; and Wm. Ritchie. He then went on to describe the general principles of photometric measurements, and showed specimens of electric lamps used to maintain the unit of candle-power. Some of the principal flame standards were also exhibited on the table. The dependence of the lumen on the candle was explained, and the units of illumination and brightness were defined and their magnitudes illustrated by means of familiar examples.

Mr. Walsh then went on to discuss the various methods used for altering the illumination of one side of a photometer head so as to obtain a brightness match in the comparison field. The inverse square method, as the most important and the most commonly used, naturally received first attention, but the other methods, based on the cosine law, the sector disc, neutral wedges, and polarizing prisms were also described in outline. In particular, various forms of variable sector were mentioned.

The final part of this lecture was devoted to a short description of those characteristics of the eye which are of chief importance to the worker in photometry. A curve of Fechner's fraction, i.e., the percentage difference of brightness just discernible at different levels of field brightness, was shown on the screen as well as the curve of response of the eye to equal amounts of energy at different parts of the spectrum (the "visibility" or "luminosity" curve). The shift of this curve at low illuminations (the Purkynje effect) was illustrated experimentally. Two patches of light, one red and one green, were thrown on the screen, and at ordinary intensities they appeared to be approximately of the same brightness. A neutral wedge was then gradually moved across the objective of the lantern so that both patches were reduced in the same ratio. It was seen very clearly that the red appeared to diminish more rapidly than the green, and, in fact, at very low intensities the green patch was still distinctly visible, although the red had completely disappeared.

The second lecture was devoted to modern methods of photometric measurement. The use of the bench for measuring the luminous intensity of light sources was described and illustrated experimentally. The Bunsen form of head was shown, and the development of this into the modern Lummer-Brodhun contrast type of head was described. Mr. Walsh gave details of the procedure adopted in working on the bench and of the precautions taken to screen the photometer from stray light.

He then went on to describe the use of integrators for measuring the total flux output from a source. He mentioned that, although the sphere was more accurate for general work, the greater simplicity of the cube had led to its adoption in many cases where only moderate accuracy was required and where the sources to be compared had approximately the same candle-power distribution. Mr. Walsh showed slides of the new 10-foot sphere which had recently been installed at the National Physical Laboratory for the measurement of large lighting fittings. He concluded this section of the lecture by an experimental demonstration of the principle of the photometric integrator, viz., that the brightness of the window was independent of the flux distribution from the source. Inside a whitened box he placed a small battery lamp, one half of the bulb of which was covered with an opaque cap. When this was rotated it was seen by the audience that there was no noticeable alteration in the brightness of the window.

The final part of this lecture was devoted to a description of the various types of portable instruments used for the measurement of illumination. By the courtesy of the manufacturers all the instruments made in this country were shown in the lecture room, and they were examined after the lecture by many members of the audience. A new model of the foot-candle meter, developed in Holland by Dr. Halbertsma, was shown for the first time in this country.

Mr. Walsh mentioned the various difficulties attending the use of illumination photometers, such as colour difference, lack of diffusion of the test surface, etc., and he concluded by describing briefly the use of such instruments for the measurement of reflection factors.

In the last lecture of the series Mr. Walsh dealt with a variety of matters. The flicker method used for the comparison of sources differing markedly in colour was described with special reference to the Guild flicker instrument. The principle of the method was illustrated experimentally, and the conditions as to field size and brightness at which the results given by a flicker photometer agreed with those obtained by means of an ordinary steady comparison head were mentioned.

Spectrophotometry was dealt with very briefly, special reference being made to the Nutting-Hilger form of instrument. Treating of physical photometry, Mr. Walsh said that the principal instruments used were the photographic plate, the selenium cell and the photoelectric cell. He felt that the only chance of improving the accuracy of photometry was by the use of some form of physical photometer, and, provided certain stringent conditions were complied with, the accuracy of comparison obtainable with a photoelectric cell was superior to that attainable by any visual method. He exhibited a rubidium photoelectric cell, and showed the current which passed through it when it was illuminated by an electric lamp.

In concluding this section of the lecture, Mr. Walsh mentioned briefly the methods used for stellar photometry, and he showed the light curve of the variable star Algol which had been obtained by the photoelectric method.

The second half of the lecture was devoted to a description of some of the applications of photometric measurement to everyday problems, such as the rating of electric lamps and the testing of their performance during life, the design of illumination systems, the examination of projection apparatus, such as ships' light lenses, lighthouses, searchlights, automobile headlights, etc. Finally, the special problem of measuring the brightness of the radium luminous compound used for painting watches and other instrument dials required to be visible at night was briefly mentioned, and the apparatus used for the measurement was described.

As in the case of all Cantor Lectures, the full account is to be published later in the Journal of the Royal Society of Arts.

# The Work of the Photometry Department of the National Physical Laboratory

*(Proceedings at the Meeting of the Illuminating Engineering Society, held at the National Physical Laboratory at 5-30 p.m. on Tuesday, April 26th.)*

A VISIT of members of the Illuminating Engineering Society and friends was paid to the National Physical Laboratory on Tuesday, April 26th. On arrival the party was welcomed by the Director (Sir Joseph Petavel, F.R.S.), and by the staff of the Photometry Department, including Dr. E. H. Rayner, Mr. J. W. T. Walsh, Mr. H. Buckley, and others.

A tour was then made of the Photometric Laboratories. Some of those present had visited the laboratory on previous occasions, but it was a revelation to many to find how the work of the Photometry Department has extended during recent years. One of the first objects that attracted attention was the large integrating sphere recently installed, 10 feet in diameter, which is very perfectly finished, and should prove a very serviceable apparatus. Measurements of total flux of light are also made with a smaller sphere 1 metre in diameter, and with 1-metre and 2-metre cubes. The rooms devoted to standard measurements, life tests, etc., were next examined, and visitors were shown the array of standard incandescent lamps which now serve as the custodian of the standard of light.

Another feature was the series of racks used for life testing of lamps, operated on alternating current from a special machine, and at a constant voltage automatically controlled by a Tyrrel regulator. In another room the mirror apparatus for obtaining polar curves of light distribution was seen, and there were many forms of special apparatus, such as the Nutting-Hilger spectrophotometer, in use. Much interest was taken in the design of the special switchboard by the aid of which a wide range of voltage, direct or alternating, can be plugged on to any department.

Another exhibit of great interest was the display of photo-electric cells of the alkali type. Varieties made at the G.E.C. Research Laboratories, at the Clarendon Laboratory, Oxford, and at the National Physical Laboratory were seen, and the special applications of these cells were illustrated. As subsequently explained in Mr. Buckley's paper, such cells are used for ascertaining when two lamps are operated at the same colour-temperature—the ingenious expedient of relating the candle-powers as measured respectively with a sodium and rubidium cell being adopted.

In another section of the laboratory, experiments with an "artificial daylight window" were shown. The effect of daylight was simulated by covering the window with diffusing material, behind which "daylight" lamps were mounted, whilst inside the room various forms of indirect artificial daylight lamps were mounted, so that their effect could be compared with that of the window.

Yet another problem requiring special apparatus is the reflection of light from road surfaces, the brightness of which, when illuminated and viewed at high angles of incidence is of importance in street lighting and in connection with motor headlight problems. The apparatus applied to the study of samples of road material consisted simply of an illuminometer, whose angle of view to the road surface is capable of variation and measurement. The source of illumination consisted of gasfilled lamps sliding in grooves on a vertical wall about 30 feet from the road surface. The illumination on the surface, as well as its brightness, is measured. The results, though as yet incomplete, show that at high angles of illumination (80° to 90°) the brightness of the road surface is very different from that which might be expected of a perfectly diffusing material; it is proportional to the candle-power of the source rather than its intrinsic brightness. Apparatus for the study of glare, by the observation of spots of variable brightness capable of being viewed against backgrounds illuminated to various degrees, was also shown.

In the new High Voltage Building, part of which is being temporarily occupied by the photometry division, an instrument is being developed for the visual photometry of light of low candle-power. The instrument, which is based on instruments described by Gehloff and Schering, and independently by Fabry and Buisson, makes use of the "Maxwellian principle," an image of the source of illumination being projected on to the pupil of the observer's eye. The lens appears uniformly bright, and its brightness may be several thousand times as great as that of an ordinary diffusing screen placed in the same position with respect to the source. By using a Lummer-Brodhun prism two fields of this type can be brought into juxta position, and, by suitable control, can be brought to photometric balance.

We have only dealt above with a few selected features of the great variety of apparatus on view. Following the tour of the laboratories there was an interval for light refreshments, after which a meeting of the Society was held. The minutes of the last meeting having been taken as read, the name of the following applicant for membership was announced:—

Ball, V. W. .....District Officer, British Electrical Development Association, 15, Savoy Street, London, W.C.

The names of applicants presented at the last meeting* were read again, and these gentlemen were formally declared members of the Society.

The CHAIRMAN (Mr. A. Blok) then called upon Mr. H. BUCKLEY to read his paper on "The Work of the Photometry Department of the National Physical Laboratory." The paper, which was fully illustrated by lantern slides, contained a most comprehensive review of recent progress in photometry, and led to an interesting discussion, in which the following took part: Mr. A. BLOK (Chairman), Dr. S. ENGLISH, Mr. C. E. GREENSLADE, Mr. S. G. ELLIOTT, Mr. T. SHORT, Capt. E. J. HALSTED HANBY, Mr. W. E. BUSH, Mr. W. C. RAFFÉ, Mr. J. S. DOW, Mr. J. W. T. WALSH, and Mr. L. GASTER. After Mr. Buckley had briefly replied to the discussion a cordial vote of thanks to Mr. Buckley for his paper, to Mr. Blok for presiding, and to the National Physical Laboratory for their hospitality, was proposed by Mr. GASTER, and carried with acclamation.

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* *The Illuminating Engineer*, May, 1922, p. 140.

# The Work of the Photometry Department at the National Physical Laboratory

By H. BUCKLEY, M.Sc., F.Inst.P. (National Physical Laboratory)

*(Paper presented at the Meeting of the Illuminating Engineering Society at the National Physical Laboratory, Teddington, at 5-30 p.m. on Tuesday, April 26th, 1927.)*

IT is now nearly twenty years since a paper on photometry at the National Physical Laboratory, by Messrs. C. C. Paterson and E. H. Rayner, appeared in the first volume of *The Illuminating Engineer*. At that time the work of the Photometry Department could be described at considerably shorter length than is necessary at present, as it consisted mainly in the maintenance of its own standards and sub-standards, the preparation of standard lamps for its various clients and the commercial testing of lamps for Government departments and others. To-day the situation is very different, and the work of the department has grown concurrently with the technical development in light production and with the growth of the illuminating engineering movement, which could hardly be said to exist 20 years ago.

In view of the wide activities of the department it will hardly be possible, in the course of a single paper, to enter into the same minuteness which characterized Paterson and Rayner's description of the work and equipment of the department. It is therefore proposed to give a brief general account of the photometric work being carried on at the National Physical Laboratory, in the hope that such an account will be of interest to the members of the Illuminating Engineering Society. For this purpose it is proposed to divide this description into the following sections, which correspond to the different types of work which are carried on in the department:

(1) Maintenance of standards and fundamental problems of photometry arising from the general problem of maintenance of standards.
(2) Test work.
(3) Special investigations arising from requests of outside organizations, such as Government Departments, British Engineering Standards Association, and the Illumination Committee of the Department of Scientific and Industrial Research, the International Commission on Illumination, etc.
(4) Miscellaneous investigations. Radium paint, life tests on thermionic valves, etc.

*Maintenance of Standards and Fundamental Problems in Photometry.*—As is probably well known to members of the Illuminating Engineering Society, the National Physical Laboratory is one of the custodians of the international unit of candle-power. This unit is based on the candle-power of the pentane lamp, and resulted from agreements effected between the three national standardizing laboratories of France, Great Britain and the United States of America in 1909. This unit has been maintained since then by means of sets of electric incandescent standard lamps in these laboratories which continue to be entrusted with its maintenance. At the same time that the international candle was adopted it was made part of the agreement, as a result of simultaneous intercomparison with the German unit in use in several of the continental countries, that the accepted value of the Hefner candle should be 0.9 international candles.

The international unit of candle-power is not a unit which can be set up from a specification. In fact the unit does not exist, but it is defined in terms of the luminous intensity of a number of standard lamps, which are, of course, liable to change. Observation has shown that the lamps in which the unit is maintained are subject to a decrease in candle-power of about 3 per cent. for every hundred hours of burning, so that if they are to continue to maintain the unit they can only be used very infrequently. In consequence they have only been used as fundamental standards for the purpose of preparing other standard lamps which can be used for working purposes and whose value is checked from time to time against the fundamental standards. As a matter of fact, they are only used on the average about one-quarter of an hour per year, so that it should be a long time before they have changed appreciably. Two intercomparisons with France and America since 1909 have shown that the unit is maintained very well in terms of these sets of electric lamps. An illustration of two of the fundamental standards kept at the laboratory are shown in Fig. 1. They are a single loop carbon-filament vacuum lamp operated at about 4 watts per candle (which gives a light of the same colour as does a tungsten lamp operated at 3 watts per candle).

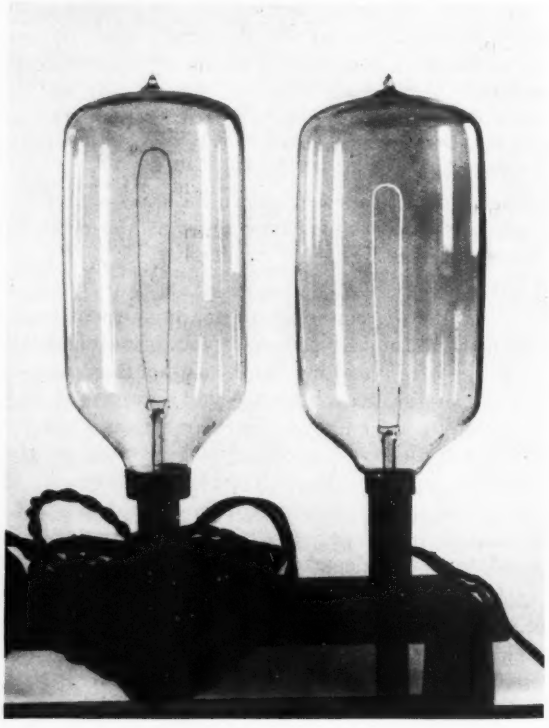


FIG. 1.—Fundamental Standards of Candle-power.

For the time being, therefore, the problem of the maintenance of the fundamental standards can be regarded as satisfactorily solved, though, of course, it would be scientifically sounder if the unit could be defined in terms of some definite unchanging physical constants of materials.

Given the fundamental standards and the derived working standards, the further problem arises of using the standards in actual practical cases where the difference in colour of the majority of illuminants is very different from that of the fundamental standards. This raises immediately the difficulties of heterochromatic photometry or the comparison of lights of different colours. The comparison of lights of the same colour presents no serious difficulties, and the same results are obtained by all observers irrespective of any abnormalities of colour vision which they exhibit.

For the heterochromatic case, at least so far as concerns differences in colour between carbon lamps operating at the same colour as the pentane flame and tungsten lamps operating at 1.5 watts per candle, the problem has been dealt with by dividing this colour difference into steps, so that the laboratory possesses six sets of standard lamps, each compared with the set nearest in

colour to it by a number of observers. It has been assumed that the average results of the number of observers concerned in building up these sets reproduces the behaviour of an observer possessing "the average eye."

The procedure in other national laboratories has been somewhat different, but in all cases colour differences more or less large have had to be encountered, and it has either been assumed or shown that the average of the observers involved represented the ideal "average observer." Intercomparisons between this country, France and America have shown that the standards operating at about the normal efficiency of tungsten vacuum lamps realized in these countries are in very fair agreement. At the same time it should be recognized that recent intercomparisons between this country and Germany and between America and Germany have shown that although the accepted ratio between the Hefner candle and the international candle has been maintained for lamps operating to give the same colour as the fundamental standards, that ratio has altered 3 per cent. for comparisons made at the higher tungsten efficiency.

It is one of the problems of the four laboratories concerned to investigate the reasons for this discrepancy, and a programme has been drawn up involving comparison of results by several methods of heterochromatic photometry.

For lamps operating at a higher efficiency than vacuum tungsten lamps the laboratory has no special standards. In this case considerable colour differences have to be faced. It is possible to halve them, however, since a substitution method is employed, and it is customary to compare a tungsten working standard against a comparison lamp used behind a bluish glass, so that the colour of the modified comparison lamp is half-way between that of the standard lamp and the lamp under test. The test lamp is then substituted for the standard lamp.

It is obvious, of course, that it would be very desirable for the laboratory to have gasfilled lamps which would be satisfactory for use as photometric standards. Experiments have been carried out during the past few years with the object of developing such standards. A number of experimental types have been submitted to the laboratory from time to time, but although some of the more recent types appear promising, the day-to-day variations on carefully aged lamps indicate that the laboratory experience of their constancy is not at the moment sufficient to justify their use as photometric standards.

There is, of course, the method of flicker photometry which has been proposed to deal with the problem of heterochromatic photometry. Here again the difficulty of being sure that a group of observers possesses the "average eye" is still present, though the most conspicuous difficulty, that of deciding when two juxtaposed fields of different colour have the same brightness, is eliminated. It is proposed to investigate the possibilities of the flicker photometer, and also the methods which have been proposed to test observers and determine their departure from the ideal average observer.

From what has been stated previously, it will be observed that the main cause of the difficulties of heterochromatic photometry is in the eye itself, and it is in consequence obvious that considerable advantage would result if the eye could be replaced by a physical instrument and photometric observations replaced by observations of a deflection of an instrument. Such an instrument would, of course, have to be calibrated so that its results would give those which would be obtained by the average eye. There is no intrinsic difficulty in this, since the properties of the eye which are involved are known well enough for most of the requirements of the photometric laboratory. One such method of physical photometry which has been proposed involves the use of photo-electric cells. Experiments have been in progress during the last two years on the use of such cells in photometry, and as a result it appears that there are considerable possibilities for their use in certain particular cases.

For some years photo-electric cells have been employed in stellar photometry and in measuring the transmission and reflection characteristics of materials, but it is only comparatively recently that any work has been done to ascertain their value for precision photometric measurements. The reason for this delay appears to lie in the lack of constancy of the photo-electric currents in gasfilled cells. Recently the General Electric Company have produced vacuum cells of sodium, potassium and rubidium, whose characteristics vary very little with time, though individual cells of the same type have slightly different characteristic curves.

Now the characteristic curves of these cells are very different from that of the eye, that is to say, they are affected differently from the eye by light of different colours, so that in comparing the visual candle-powers of lamps by photo-electric means the lamps must all be operated at the same colour. This gave the first problem, which has been solved very satisfactorily. For two lamps will have the same colour if the ratios of their sodium cell candle-powers to their rubidium candle-powers are the same. By this means it has been found possible to colour match two lamps to an accuracy of 0.1 per cent. in volts, whereas ordinary visual colour matching is only accurate to about 1 per cent. in volts. This means that two lamps can be adjusted to within 1° in temperature, since the temperature of operation defines the colour of the light emitted.

The preceding argument holds only if the tungsten in the lamps and the glass of the lamp bulbs have the same properties. Unfortunately the bulbs are not so uniform as is desired, largely owing to the use of gettering in the manufacturing process, so that the present position is that if colour matches are possible to 0.1 per cent. in volts they can be so colour-matched by photo-electric means, though lamps as now made will not fulfil the colour-match condition to this accuracy.

It has been found, however, by Campbell that a Wratten K.9 filter in conjunction with a rubidium cell gives a cell which reproduces closely the average eye, and that an error of 1 per cent. in the colour-match voltage produces an error of about 0.1 per cent. in candle-power measurements when this compound cell is used. Now no two lamps are so different that they cannot be matched to within ½ per cent. in volts, so that candle-power measurements should be accurate to 0.05 per cent. The experimental consistency obtained appears to be about 0.2 per cent., and the result agrees with the visual method, so that the point has been reached when it is more difficult to eliminate the errors in the mechanical and electrical adjustments of the lamps than in the photo-electric measuring system.

Since the date of Paterson and Rayner's paper the measurement of the total light given out by a lamp, i.e., its mean spherical candle-power, has become of importance, and the laboratory equipment has grown in consequence of the demand for this type of measurement. For this purpose some form of photometric integrator has to be used. This instrument depends on a principle first enunciated by Sumpner in 1892, who showed that

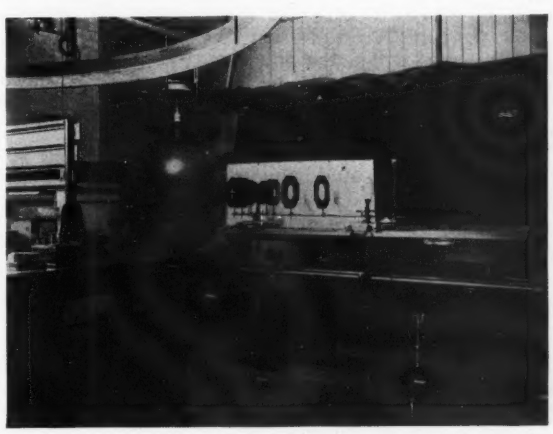


FIG. 2.—Meter Integrating Sphere.

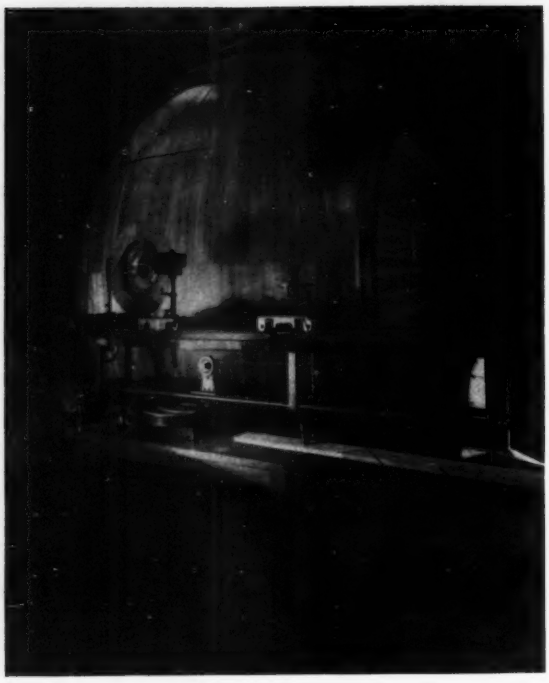


FIG. 3.—10 ft. Integrating Sphere.

if a source of light were placed inside a hollow sphere coated with a perfectly diffusing material the brightness of the spherical surface due to reflected light was uniform all over and proportional to the mean spherical candle-power of the source. The proposal to use a sphere for measurement of mean spherical candle-power was made by Ulbricht in 1900, and since that date they have been used extensively for this purpose.

The laboratory has three integrators working on this principle. The first is in the form of a 2-metre cube, which is not quite as sound theoretically as the sphere, but it gives correct results in comparisons of sources having similar light distributions. The spherical shape was adopted for the two others in use in the department, one of which is of 1-metre diameter and the other of 10-feet diameter. These integrators are shown in Figs. 2, 3 and 4.

The use of the photometric integrator has necessitated the preparation of a number of standard lamps of known mean spherical candle-power, which is determined by averaging the candle-power of the lamp determined in a sufficiently large number of directions. The mean spherical candle-power of other lamps is then determined by comparison with these standards using the substitution method.

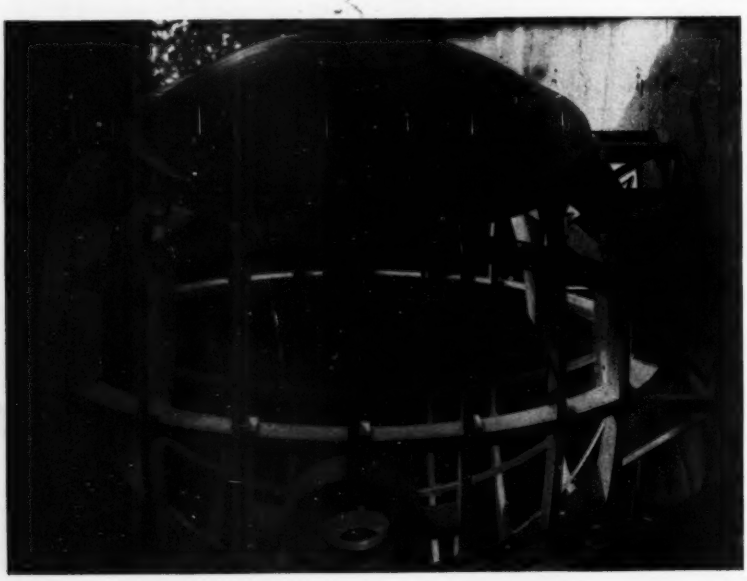


FIG. 4.—10 ft. Integrating Sphere in Construction.

*Test Work.*—The laboratory undertakes any investigatory tests into the properties of materials as distinct from contractual test, which are only undertaken:

(1) When they are required for Government departments;

(2) When the tests cannot be carried out adequately in private establishments;

(3) When they arise as reference tests agreed as such between parties to a contract or referred to the laboratory by a Court.

The laboratory also undertakes the testing and verification of any instruments.

The main portion of the test work of the department is concerned with the standardization of lamps, both flame and electric. In the case of flame standards the standardization includes the measurements of the different parts of the lamps in order to determine whether they have been constructed in accordance with the official specifications. In the case of electric lamps, unless specific instructions to the contrary are received, they are aged at least 50 hours, or as long as may be necessary to ensure that the initial irregularities of candle-power have ceased and that the rate of fall of candle-power does not exceed 3 per cent. per 100 hours. Satisfactory vacuum lamps are then measured for candle-power to an accuracy 0.25 per cent. (for lamps of normal candle-power) in a direction specified in the laboratory certificate issued. The lamps are marked on the bulb with the laboratory monogram and an identification number.

The standardization of gasfilled lamps is not at present undertaken by the laboratory owing to the liability of these lamps to behave irregularly. They are, however, prepared for use as laboratory reference lamps, and a report is given of their candle-power to an accuracy of about 1 per cent. It may be assumed that there is every probability, as shown by the ageing readings, that the value of candle-power given will remain reasonably constant over a burning period of 50 to 100 hours.

Vacuum lamps are also standardized to an accuracy of about 0.5 per cent. for mean spherical candle-power, while for gasfilled lamps a report is made of the mean spherical candle-power to an accuracy of about 1 per cent.

Other tests carried out are commercial tests to about 1–2 per cent. on all types of electric lamps, gas lamps with incandescent mantles, arc lamps, acetylene lamps, and oil lamps. The tests on gas lamps with incandescent mantles also include measurement of the pressure, the rate of consumption and the calorific value of the gas, all measured at the same time as the candle-power.

A further branch of the testing work carried on is the testing of lamps for life. A life test on a lamp is in effect a test of the quality of the filament as regards uniformity and ability to stand the high temperature of operation without too rapid volatilization or deterioration. Owing to individual variations in lamps it is very difficult to ensure that a batch of lamps all with the same rating should all have the same operating temperature. Now it has been shown that the life of tungsten lamps, for example, varies as about the inverse 30th power of the temperature, so that it is essential, if the life test is to give satisfactory information about the filaments, that they should all be operated at the same temperature. This is accomplished by running the lamps on life test, not at the rated voltage, but at the rated efficiency, since for the same efficiency of operation lamps of the same type will be operated at the same temperature.

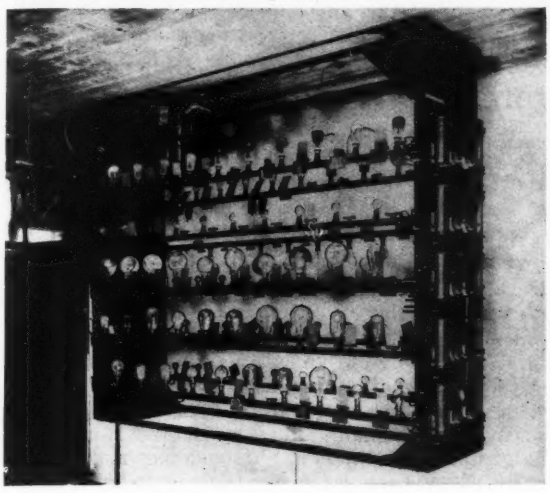


FIG. 5.—Life-test Racks.

Lamps for life test are measured for efficiency at several voltages and the voltage for the life test efficiency found by interpolation. It is anticipated that the photo-electric cell apparatus will be useful in this adjustment to a definite efficiency, since when two lamps of the same type are colour-matched they are operating at the same efficiency or temperature. Before, and from time to time during the life test, the lamps are measured for candle-power at the rated voltage.

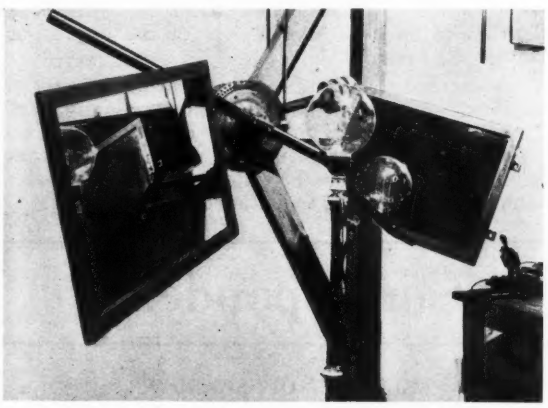


FIG. 6.—Polar Curve Mirror Apparatus.

The racks for life testing lamps are shown in Fig. 5. These are operated on alternating current from a machine specially used for this purpose, and the voltage on the racks is maintained constant well within the limits of plus or minus one-half per cent. by means of a Tyrrill regulator.

A feature of the test work which has been growing in the last few years is the determination of the polar curves of light distribution from lamps and fittings of which the following types, among others, have been tested: R.L.M., industrial reflector (No. 1), diffusing bowls of many kinds, acetylene flares, motor-car headlights, lighthouse lamps, street-lighting lamps, etc. An illustration of the mirror apparatus for determining polar curves is shown in Fig. 6. The use of the rotating mirror, in which the source under test can be viewed at all angles of azimuth, gets rid of the necessity for moving the source itself.

Portable photometers have also been tested from time to time.

*(To be continued.)*

# Road Transport Lighting

THERE was an interesting discussion in connection with the second reading of the Road Transport Lighting Bill in the House of Commons on April 1st.

Mr. Lougher, in introducing the Bill, pointed out the troublesome variations in the regulations of local authorities in different areas. The Bill now before the House adopted many suitable clauses appearing in old Acts, but especially the recommendations of Sir Henry Maybury's Committee. Clause 1 in the Bill prescribes that every vehicle on any road shall carry during the hours of darkness two white lights showing to the front, and a red lamp showing to the rear. This is a very drastic clause, and, accordingly, some modifications and exemptions are necessary. These apply, for instance, to vehicles carrying agricultural produce and inflammable or explosive material. Again, subject to suitable illumination being provided at a parking station, motor cars parked at such stations may be exempted from showing lights. In the case of pony-chaises, horse-drawn vehicles, etc., a white light in front and a red light at the rear is considered sufficient. Special provision has, however, to be made for the lighting of vehicles carrying overhanging loads (such as timber carts with poles projecting 10 or 15 feet in the rear). The hours of darkness are taken to mean the time between one hour after sunset and one hour before sunrise in summer, and half an hour after sunset and half an hour before sunrise in winter.

Clause 2 deals with the nature of lights and limits their number; but, again, provisions have to be made for omnibuses, taxi-cabs, etc., which have special lamps for lighting destination boards, etc. Clause 3 is out to deal with dazzle lights. When a satisfactory method of dealing with such lights has been found, the Minister will be empowered to make the necessary regulations. Clause 4 gives permission for an additional lamp to be carried for use during fog, or in the event of breakdowns. Clause 5 deals with bicycles and tricycles. Bicycles with side-cars and tricycles propelled by mechanical power must carry two front white lights and one rear red lamp; motor-cycles, one white front lamp and one red rear lamp. Pedal bicycles and tricycles need only carry one front light together with either a rear lamp or a reflector.

In the discussion much attention was devoted to the vexed question whether bicycles should be compelled to carry rear lights. Some speakers considered this essential for safety, but the difficulty in ensuring that oil lamps fixed to the rear of a pedal bicycle will keep burning was pointed out. Great importance was attached to the efficient design of reflectors; some unsuitably designed types are of very little value.

Sir Park Goff, in seconding the motion, also drew attention to the inconveniences arising from the independent action of local authorities. Under the Lights on Vehicles Act of 1907 they had three alternatives as to the by-laws they might pass. Some boroughs sanctioned the use of reflectors by pedal bicycles; others insisted on rear lamps. A uniform system was needed. Sir Park Goff also drew attention to the great increase in road accidents. In 1920, 495 people were killed by day; in 1926 the number was 687. In 1920, 143 people were killed at night; in 1926, 316. Similarly, the number injured by day was 16,225 in 1920, and 35,130 in 1926; those injured at night numbered 3,338 in 1920, and 10,906 in 1926. Reference was subsequently made to these figures by Mr. B. Smith, who urged that they illustrated strongly the necessity for some effort to get proper lighting.

Incidentally, Colonel Wedgwood drew a striking picture of conditions on roads in the United States. He urged that the effect of the Bill would be to enable motorists to drive more quickly, but not to promote the public safety. He regarded it as much more important that something should be done to restrict the use of unduly dazzling headlights.

Ultimately, the Bill was read a second time and committed to a Standing Committee.

## Mercury-Vapour Lamps and Chicken-Hatching

A recent contribution to the *Transactions* of the Illuminating Engineering Society (U.S.A.) describes the application of light from the mercury-vapour lamp to encourage the growth of chickens. Two lots of fifth-day-old chicks were placed in exactly similar pens in the nutrition house. The treatment was exactly the same, except that a south window was kept open (during the daytime) in one pen, and closed in the other. The chicks receiving the light through the open window grew normally, whilst those receiving the glass-filtered light developed typical avian rickets (leg weakness). The growth of the chicks receiving light from the window was also much superior, as is illustrated in the original paper by photographs showing the condition of the two lots of chicks at the end of the experiment.

Such results as these, confirmed by many other experiments, emphasize the lack of health-giving rays in the glass-filtered light in some offices and factories. It is, however, possible to replace the natural light by suitable artificial illuminants, which contain a sufficiency of the desirable rays. Very interesting results have been obtained by using the Cooper-Hewitt mercury-vapour lamp. As the light from this lamp filters through a glass tube, it was thought that it would have no more beneficial effect than sunlight filtered through window glass. But this was not the case. Photographs in the original paper show the appearance of chicks treated alike, but receiving respectively (1) light through window-glass all day, (2) light from mercury lamp two hours daily, and (3) light from mercury lamp six hours daily, the lamp being approximately three feet above the chicks. The two hours' exposure led to a marked improvement in strength and growth; with the six hours' treatment the chicks were fully normal.

Following these tests, a careful test of the spectrum of the transmitted light was made. This showed that the lead glass of which the tube is made transmitted the ultra-violet rays much better than ordinary window glass. The spectrum of the mercury-vapour lamp was found to contain a substantial proportion of the ultra-violet rays of longer wavelengths, whilst checking those of very short wavelength, which, in excess, are liable to have a detrimental effect. These researches seem to confirm the experience of other investigators who have found that light exercises an important influence on poultry farming. It would be interesting to know how much the effect is really due to visible light, and how much to the ultra-violet.

## National "Safety First" Association

### National Scheme for Drivers.

An important feature of recent developments in the work of the National "Safety First" Association is the extension of the "Freedom from Accidents" Competition for drivers to the whole of Great Britain. Hitherto this competition has been confined to London and other Area Councils. The experience of London (where, among others, several thousand bus drivers are entered) has proved the value of the competition. No fewer than 352 silver medals and 7,780 diplomas have been awarded amongst the 15,000 drivers who entered.

The competition is open to all drivers of any class of road vehicle (including tramcars and horse-driven vehicles) who are employed by local undertakings, by commercial and other undertakings, and by individuals who are members of or who subscribe to the National "Safety First" Association. A silver medal is awarded to every driver who completes five consecutive years free from blameworthy accident. At the end of each year, free from accident, each driver gets a diploma; after holding diplomas for five consecutive years he is granted the silver medal, and a bar for each succeeding year in which he qualifies. The idea of awarding a gold medallion to drivers who go for ten years free from blameworthy accident, or hold 15 diplomas in 20 years, is under consideration.

## The Coal Fire—Its Claims for Affection

To some people it may appear a puzzle that the coal fire, which, from a scientific standpoint, is an anachronism, should continue in public favour. It is undeniably wasteful and responsible for much of the pollution of the atmosphere. It occasions much extra cleaning of walls and decorations; it has the inconvenient quality of requiring constant attention, adds to the household labour, and, unlike the gas or electrical radiators, is not available the moment it is wanted. Why, then, does it continue to exist?

A possible answer was supplied to the writer by a lady with whom he discussed this question. It represents a point of view that deserves consideration, and which is akin to the feeling of those who cling to ancient styles of lighting in spite of their inefficiency and practical inconvenience. "Gas and electrical fires," she said, "are efficient but inhuman. The electric radiator is silent. The gas fire not always so; it sometimes makes a buzz, but the noise is regular, and irritating rather than comforting. It is the noise of a machine, not of a living thing. But the crackle and sizzling of the fire, like the singing of the kettle, is a variable and friendly sound, just as the flickering of the flame is more interesting and comforting than the dull steady glow of gas or electric heating agents. The latter, once turned on, need no attention. They spring at once into full function—an unnatural process. The coal fire must be carefully nursed into life. Its sounds and varying light denote that it *is* alive, a companion whose needs must be met in gratitude for the warmth received. After the day's work one can sit by the fire alone, without feeling lonely. The occasional tending it requires is an agreeable task in moments of relaxation. Whilst the gas fire and the electric radiator answer excellently for the office or the bedroom, to my mind the ideal sitting-room, where one rests after the labours of the day, should always have a coal fire."

How can advocates of scientific methods meet this objection? It is true that in modern gas and electric radiators a fair visual imitation of the coal fire is possible; but it is obvious that the efficiency is irreconcilable with the capricious behaviour of glowing coal. A fundamental difference in outlook is involved.

# Correspondence

### EFFECTS OF SHADOWS.

Sir,—Dr. Halbertsma's charming series of illustrations in the March issue illustrated one point that few people seem to understand—that diffused lighting is not necessarily the best for revealing all objects. People often talk as though all one need do is to imitate daylight. Fig. 3, on page 76, showed that for a bas-relief a clear-bulb electric lamp is much better than the same lamp placed behind tracing paper and giving more diffused light. It may often happen in practice that carved designs appear better when lighted by a small source, giving sharp shadows, though (as the previous illustration, Fig. 2, showed) this is not usually so. A similar point arises in certain forms of fine work, such as engraving where one has to deal both with projections and recesses scooped out of the material. I have met a case in which workers insisted on having local lights, because, by moving the lamps about, they could alter the shadows and see the design more clearly. They evidently did not like diffused light. One would imagine that compositors, in picking type out of a box, have somewhat the same requirements, and this may explain why some workers cling to the local light from a clear-bulb lamp, notwithstanding its other disadvantages. This form of difficulty cannot be met by giving higher illumination—it is the direction from which the light comes and the size of the source that are important

Yours truly,

Enquirer.

# POPULAR & TRADE SECTION

COMPRISING

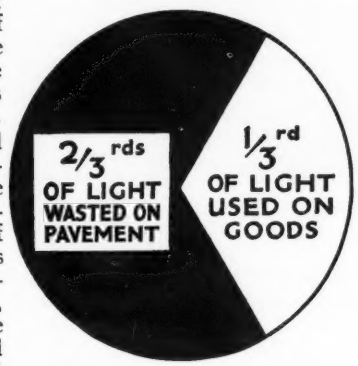
**Installation Topics—Hygiene and Safety—Data for Contractors—Hints to Consumers**

*(The matter in this section does not form part of the official Transactions of the Illuminating Engineering Society; and is based on outside contributions.)*

## The Lighting of Shops and Stores

*SHOW Windows.*—It is a recognized fact that it pays to advertise, but as there are so many methods from which to choose some consideration is necessary to decide the precise manner of attracting the greatest number of people in the cheapest possible way, and there is little doubt that one of the cheapest forms of advertising is a well-lighted shop window. A small investment in good lighting will more than pay for itself.

By means of artificial lighting the hours of commercial activity can be extended, but it is surprising to find how abundant are instances of light being used in the wrong way. It cannot be overemphasized that a bare lamp hung in the window is not only wasteful and deleterious to eyesight, but it also reduces visual acuity. Of the total amount of "raw" light emitted by the bare lamp, only one-third of the light illuminates the goods in the shop window, the rest is wasted in lighting up the ceiling, and in passing through the window on to the pavement. If, however, the same lamp be placed in a shop-window type of reflector at the top of the window, then the goods will receive over three times as much light as before.




In recent years all manufacturers of electrical material have given special attention to the design of reflectors and fittings for the effective lighting of shop windows, which will control the "raw" light emitted by the lamp and direct it on the goods that are displayed.

As the various branches of shop-window lighting are dealt with in Handbook No. 3, it is only necessary here to make brief mention of the possibilities in this direction.

We now have means of illumination whose possibilities are enormous, and the shop window can be made a thing of real beauty. Gasfilled lamps are placed in suitable reflectors at the top of the window, and the light source is completely hidden from the shop gazer. The intensity of illumination required to ensure good results obviously varies with the nature of the goods displayed. For instance, dark materials require more light for display than light goods in order to make them equally attractive. It can, however, be safely stated that in all cases the higher the intensity of light, the greater the attraction will be.

It was found from some tests that a shop window which was lighted to 15 foot-candles illumination had an average of 200 people stopping per hour. Increasing the illumination to 40 foot-candles resulted in 244 people stopping per hour, and a further increase to 100 foot-candles resulted in 284 people stopping per hour; a tremendous gain of 42 per cent. for a very slight outlay in electrical energy, which at 6d. per unit represents the sum of 7½d. per hour.

Coloured lighting presents a still larger field, for shop windows lighted with carefully chosen coloured light sources cannot fail to attract the majority of the passers-by, and bring additional business to the store which is enterprising enough to install such equipment.

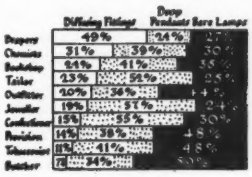
With quite simple switching arrangements it is possible to light the window with one colour one night and a mixture of colours another night, and thus merely by the aid of lighting provide the change in the appearance of a shop so necessary in order to attract constant attention. Most people are attracted by objects that move, and a change of light is tantamount to movement.

The suitable arrangement of flashing devices in conjunction with colour schemes, chosen with discrimination, produces wonderful effects which cannot fail to attract.

It has been shown that by definite co-operation in the better lighting of windows it is possible to divert the majority of people to a particular street or section of a street. In one instance the shopkeepers on the west side of a road were persuaded to increase their illumination by more than 100 per cent., and this resulted in inducing the majority of the users of the thoroughfare to walk on this side.

*Shop Interiors.* Not long ago an interesting experiment was conducted in a stores where modern equipment had recently been installed. Results obtained under this new system were compared with those obtained when obsolete spider fittings and a few inefficient lamps were in use. During a period of five weeks the two systems were employed on different days, and it was found that each time the up-to-date system was in use the sales increased, but declined again as soon as the lighting reverted to its earlier condition. By increasing the amount of light from approximately 3 foot-candles to good lighting of 15 foot-candles, the number of purchases was increased by 11 per cent. and the value of the sales increased by 29 per cent.

**HOW RETAILERS LIGHT THEIR SHOPS**




**TURNING THE BLACK INTO WHITE IS THE PROBLEM OF THE ELECTRICAL INDUSTRY**

With the general appreciation of good lighting it is natural to find that the antiquated type of pendant is gradually being superseded by larger and more decorative lighting units. It is now realized that the more light available in the interior of a shop the easier it becomes for customers to see, and the easier to sell goods. So

important has become the effect of good lighting on sales that the question to-day is not whether the shopkeeper can afford it, but whether he can afford to be without it.

A recent survey indicates that antiquated equipment is still prevalent in the interiors of shops in this country. The accompanying diagram shows the widespread use of glaring light sources, and the comparatively infrequent installation of modern diffusing equipment. Moreover, it indicates that in addition to bare lamps there are many obsolete pendants which could be economically replaced by modern units.

Hence the business of the electrical industry is to turn the black and spotted portions of the diagram into white as quickly as possible.

In E.L.M.A. Handbook No. 3 full information is given regarding the choice and employment of suitable shop-lighting equipment, while several examples of typical installations are given for the guidance of those desiring to calculate the units required for particular cases.

At the present time there are a large number of cheap fittings on the market with glassware that gives a poor factor of diffusion, and whose lighting result is unsatisfactory because of glare. It is not usually appreciated that reliable makes of totally enclosed glassware absorb very little of the light, and at the same time render the filament of the lamp invisible. In general, the use of direct or semi-indirect bowl fittings is to be discouraged owing to the rapid drop in the illumination that occurs, due to the deposit of dust. With units of this type it is quite common to find that the lighting system deteriorates by 40 per cent. in four or five weeks from this cause, whereas by the use of totally enclosed glass units the depreciation does not exceed 12 per cent. in the same period.

## A Demonstration of Stage Lighting

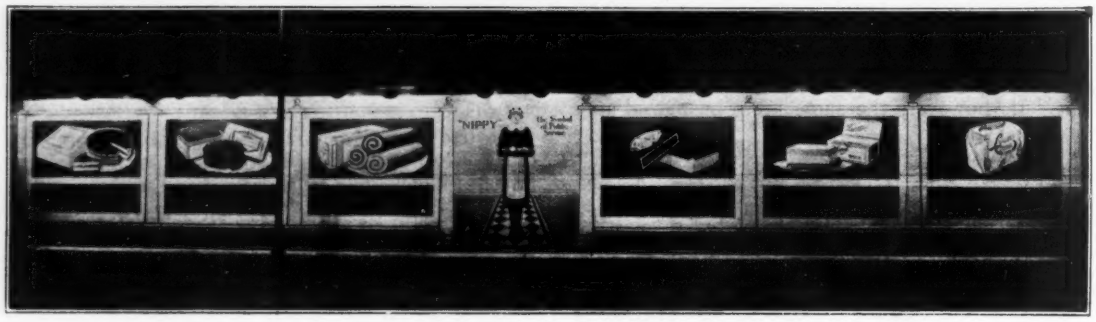
An interesting demonstration was given by Mr. Lester Groom in the new stage-lighting showrooms of the General Electric Co. Ltd., at Magnet House, Kingsway, London, on May 10th. Many of the devices shown, including the striking Schwabe-Haseit cyclorama and cloud apparatus, were described in Mr. Groom's recent paper before the Illuminating Engineering Society, and have been fully recorded in this journal. But the collection of varied devices for stage illumination was impressive as showing the resources now available, and the assembly of these implements in a special showroom is an enterprising step.

In the early part of his discourse Mr. Groom showed a considerable variety of spotlights and floodlighting units equipped with colour screens, the design of which has been steadily improving during recent years. These ranged in size from a very compact spotlamp containing a 100-watt lamp to the very powerful 1,500-watt horizontal type projector. There were also a number of special devices for "effects," such as the special arc-lamps with flame carbons, the rapid switching on and off of which furnishes "stage lightning."

The chief feature of the demonstration, however, was the display given with the Schwabe-Haseit system. The "artificial horizon" now plays an important part in stage lighting, and is built up by the skilful use of a variety of colour units. One saw in operation the familiar cylindrical horizon floods, each of which furnishes its distinctive colour and spreads the light over approximately 180°. Each of these contains a special tubular 1,000-watt lamp, and their combination permits almost any changing tint of colour to be obtained. A useful accessory is the mobile ground flood, which consists of two 1,000-watt units mounted on a light metal trolly; these often serve a valuable purpose in strengthening the illumination on the lower part of the horizon. We were also keenly interested in the design of a special floodlight apparatus which, in some circumstances, may replace the series of cylindrical units. This is of the magazine type, carrying colour slides operated by steel wires running over pulleys to control gear, and permits a great variety of colour effects; on the small stage this may also serve as a substitute for battens.

The now familiar cloud apparatus was also seen in operation. For details of this apparatus readers may be referred to Mr. Groom's original paper, but it will be recalled that the cloud effects are produced by the slow rotation of a system of pictures, lenses and mirrors, light being furnished by a central 3,000-watt lamp. A feature of this apparatus is the arrangement of the lenses in two tiers, operated by motors at different speeds. In this way two series of clouds may be made to travel across the sky at different speeds, an effect which is not infrequently seen in nature. A useful supplement to the cloud apparatus is the panorama projection set, by which different panorama effects may be projected.

Following the demonstration visitors were entertained to luncheon at the Connaught Rooms, over which Mr. W. H. Roberts presided.




An Effective Display of Illuminated Posters.
*(Photo by the courtesy of Messrs. J. Lyons & Co. Ltd.)*

## Illuminated Posters

It is commonly said that in no department of art has there been such a great advance during recent years as in poster design. It must be admitted that the attractiveness of the pictorial advertisement has vastly improved—to a degree that can only be appreciated by those who remember the crude and ineffective displays of the past. Even the most attractive poster, however, loses much of its utility if it is only visible during the day. At night time, when people in the streets have more leisure to look about them, the poster has a special opportunity. Hence the growing tendency to apply floodlighting to such advertisements. Properly illuminated, a poster becomes even more attractive by night than by day. At the same time the provision of sufficient and uniform illumination not infrequently presents difficulties, and considerable skill is often required to get a really good result.

The accompanying illustration shows a very effective example of hoarding lighting. Each of the seven pictures is illuminated by two Benjamin elliptical angle reflectors, each containing a 100-watt lamp and spaced approximately five feet apart. We understand that the photograph was taken by the unaided light of the fittings shown, and has not been retouched in any way.

# The Development of Gas Supply in Liverpool

## A Fascinating History

*Mr. R. E. Gibson, Engineer of the Liverpool Gas Company, is to be congratulated on his interesting lecture recently delivered before the Society of Lovers of Old Liverpool, part of which is reprinted below. The second half of the lecture will appear in a subsequent issue of this journal.*

(*Continued from p.* 154, *May*, 1927.)

*WAR Period* (1914-18).—Prior to August, 1914, the gas industry supplied the needs of the community for lighting, heating, cooking and power purposes only; and no one in the industry probably ever dreamed that it would be called upon to fulfil a great national need by supplying material for high explosives in war; yet it so happened. The Liverpool Gas Company, along with gas undertakings throughout the country, were called upon to make extra quantities of benzol, toluol and ammonia for the production of munitions of war. Without that assistance (given when the nation was in dire extremity) it is certain that the German army would have been victorious. In the words of Lord Moulton, Director-General of Explosives of the Ministry of Munitions: "The gas industry—typically peaceful in character and aims—furnished material for purely war purposes, without which it would have been impossible to maintain the fight." If a world-war should ever again take place (which God forbid!) the gas industry would no doubt again be ready to place its resources at the service of the nation.

Throughout the war, the Liverpool Gas Co., in common with other undertakings, passed through a trying and anxious time. A large number of the company's workmen and office staff were called to the colours, and women were employed to a considerable extent, not only for office work, but for heavy manual labour. In 1917, under the Coal Transport Reorganization Scheme of the Government, practically the whole of the company's usual sources of coal supply were cut off; and coal from other sources—much of it very unsuitable and inferior in quality—was substituted, and great difficulty was experienced in obtaining it. There were many other difficulties. Special precautions had to be taken at night when air-raid warnings were given, calling for the utmost watchfulness. Lights were put out and pressures reduced.

In July, 1918, the Government issued an Order strictly rationing gas and coke, an Order which caused great inconvenience at the time. It will also be remembered that, owing to the shortage in motor spirit, gas came to the rescue; and it was no uncommon thing to see motor vehicles in the streets with a large bag on the top containing gas for use as motive power.

*Gas Regulation Act.*—In 1920 the Government introduced new legislation, known as the Gas Regulation Act, 1920, whereby it became compulsory for gas companies to charge according to the thermal value of the gas. The Act rectified some anomalies which had arisen in consequence of the war, but placed further restrictions on gas undertakings with regard to quality, pressure and other matters.

*The Works.*—With regard to the manufacturing stations, the original installations at Dale Street and Rose Hill were discarded at an early period in favour of larger premises in Eccles Street and Athol Street, both conveniently situated on the Leeds and Liverpool Canal for receiving coal by water. Although the plant and apparatus have been replaced from time to time by other plant of improved design, most of the old buildings remain intact and are a credit to those who erected them about 100 years ago.

In 1847 additional works were erected in Caryl Street (then called Harrington Street). These works were closed down as a manufacturing station in January, 1925, but are still used for storage and as a distributing station.

The Wavertree works were erected in 1856, being the first of the Liverpool works to be connected to a railway system. Many improvements and extensions have been carried out there and labour-saving machinery installed during the last 20 years. The development of Liverpool in a northerly direction following the extension of the docks, and the growth of Bootle, led to the erection of the Linacre gasworks in 1867, which are now the largest works of the company, and are provided with many of the most modern improvements in the manufacture of gas. Like Athol Street and Eccles Street, Linacre is on the canal, but has also the advantage of a railway connection.

The latest addition to the works of the company was at Garston, at the southern end of the city, opened in 1895. The land on which these works were erected is 32 acres in extent, situated alongside the L.M. & S. Railway, providing room for extension for some years to come.

Prior to 1922 these works had the distinction of being the only gasworks in Europe in which carburetted water gas only was being made. In that year a large modern section of coal-gas plant was erected to meet the ever-growing demand for gas.

*Growth of Consumption of Gas.*—The following statistics may be of interest as showing the growth in the use of gas in Liverpool.

In 1837, at the beginning of the reign of Queen Victoria, the output of the two companies together was 129,287,000 cubic feet, and the price was 10s. per 1,000 cubic feet. The number of street lamps was 2,456. The gasholders were few in number, the largest being at Athol Street, with a capacity of only 120,000 cubic feet.

In 1904, when Mr. H. Wade Deacon became chairman of the company, the annual output was 4,000 millions of cubic feet and the price 2s. 8d. per 1,000 cubic feet. There were 22,000 street lamps, and the gasholders were 26 in number, the largest (at Garston) having a capacity of 4,000,000 cubic feet. In 1926 the output was 7,724 million cubic feet; the price (affected, of course, by the recent coal stoppage) is 9d. per therm; the number of street lamps is 24,000, and there are 27 gasholders and 1,000 miles of mains.

*Improvements.*—It is interesting to note the periods when various alterations and improvements were introduced in the process of manufacture. For instance, coke was used for the first time for heating the retorts in 1833. In the same year dry lime was employed for purification of the gas, wet or cream of lime having been used previously. Oxide of iron had largely superseded the use of dry lime by the year 1858.

The first station meter for registering the production of gas was erected in the year 1822.

In the early days coal was carbonized in retorts made of iron, and these retorts were still in use in 1837; but subsequently fireclay retorts came into general use. The fireclay retorts have, during the last few years, been giving place to silica retorts, which are capable of withstanding higher temperatures, as well as lasting much longer.

The form of the gas retort has undergone many changes; the standard practice was to use horizontal retorts of "D" or oval section, at first open at one end only; but later open at both ends. Inclined retorts were introduced about the year 1885. The latest form is the vertical retort, which had been tried by Murdoch as far back as 1802, and again by Scott in 1874, but without success.

At the present time vertical retorts are coming into more and more general use, and vie with the improved horizontal retorts; their advocates claiming larger yield

of gas, better working conditions, smaller ground space, and other advantages.

It is of very great importance that the gas mains in the streets should be absolutely tight; and it is to the credit of the late Mr. Alfred King that he invented the turned and bored joint for gas mains, which is still in use to-day.

The introduction of the gas meter for measuring the consumers' gas has already been referred to. At first these meters were not tested for correctness, and it is not surprising that the meter got into disrepute as a perverter of the truth.

Under the Sale of Gas Act, 1859, however, it became unlawful for any meter to be used for the sale of gas which had not been tested, and whose accuracy had not been certified by a Government inspector. This wise legislative Act ensures satisfaction both to the seller and buyer of gas.

As gas was used at first solely for lighting in the flat-flame or Argand burner, its illuminating power was a matter of great importance, and Parliament soon laid down stringent regulations with regard to this, and an illuminating power standard continued in use until 1914. Liverpool was always noted for its very high standard of illuminating power. By the Liverpool Gas Act, 1914, the test for illuminating power was abolished, and a test for calorific value was substituted; the methods of using gas having changed and the flat-flame burner having become obsolete. Gas, whether it be used for light, heat or power is now valued according to the number of heat units it contains. It may be said that no commodity supplied to the public for general use is so carefully and so frequently tested as the public supply of gas.

*Carburetted Water Gas.*—The manufacture of carburetted water gas was introduced into this country from America in 1890. Liverpool was one of the first towns to be supplied with it. Although there has been a great deal of prejudice against it, on account of its high carbon monoxide content, it is in many ways better than coal gas. Its flame temperature is more intense, it requires less air for combustion, and sometimes the cost of manufacture is less than that of coal gas.

*Area of Supply.*—Under the Act of 1818 the original company were given power to supply gas to the port and town of Liverpool and to the adjoining township of Toxteth. In 1823 the Liverpool Oil Gas Light Co. obtained power to supply the town of Liverpool, also the townships of Everton, Kirkdale, West Derby and Toxteth Park. An extension of area took place by the Act of 1841, when the Liverpool United Gas Light Co. acquired the right to supply the townships of Walton, Bootle, Litherland, Great Crosby, Wavertree and Garston, in addition to those townships mentioned in the Oil Gas Act of 1823. Under the Act of 1880 the limits of supply were again extended to include Orrell and Ford.

The next extension of area did not take place until the passing of the Act of 1914, when Childwall, Aintree, Netherton, Sefton, Lunt, Ince Blundell, and Thornton were provided for. Under the Liverpool Gas Order, 1915, the Fazakerley area was transferred from the Corporation to the company.

During the last two years, by virtue of Board of Trade Orders issued under provisions of the Gas Regulation Act, 1920, further additions have been made by the inclusion of Little Crosby (including Hightown), Woolton, and parts of Halewood and Speke. The districts now in the company's area of supply comprise about 64 square miles, extending from Hightown in the north to Speke in the south, and cover the major part of the historic Hundred of West Derby.

*Gas Lighting.*—The basic idea of the original gas burner was a pin-hole pierced in iron or other metal, producing a jet. When two jets were made to impinge upon one another, producing a fan of flame, they were called fishtail or batswing burners. The Argand quickly followed the flat-flame. In the early "eighties" of the last century the inverted Argand was converted into a kind of regenerative shadowless burner, known as the Wenham.

The discovery of the incandescent mantle and its development on a commercial scale revolutionized gas lighting. Its introduction took place about 1880, although many attempts had been made to evolve a light of this kind, even as far back as 1839, when Talbot noticed that blotting paper soaked in calcium chloride solution, dried and heated in a spirit lamp, gave a surprisingly brilliant light.

We are, however, indebted to Welsbach for discovering how to manufacture and use the rare earths on a commercial scale. Somebody found Monazite sand in Brazil, where nature had hidden it away in large sand-pits, from which the rare earths are extracted. Welsbach's process consisted in soaking an open fabric in a solution of the nitrates of rare earths, then burning away the fabric, which left the ash in the form of oxide. He sent his first mantle from Vienna into this country suspended in a bird cage. The price for burner and mantle in those days was 27s. Since then great improvements have been made. The discovery of the great value of cerium in 1891 was an important step in mantle making, as a very small proportion of this substance improved the illuminating value nearly threefold. A further improvement was made about 1896, when collodion was first used for protecting the fragile structure of the mantle during transport from the makers' works to the consumer's burner.* The inverted mantle was introduced in 1897.

The tendency fourteen years ago was to make large inverted mantles known as the Grätzin type, but to-day the inclination is to use small mantles in a cluster in conjunction with a superheater. These are stronger, last longer, and give much greater illuminating efficiency than the larger ones previously used. Gas, used in an up-to-date burner, is a satisfactory and economical means of illumination. Its soft light is not trying to the eyesight. Gas for street lighting is reliable and has great penetration in fog. For domestic use, gas for lighting promotes ventilation, and does much to sterilize the air of a room vitiated by the respiration of the occupants.

*Gas for Cooking Purposes.*—As already mentioned, gas was originally used solely for lighting purposes; but although its heat-giving properties must at once have been recognized, its progress, at first, as a heating agent was slow. It is interesting to recall that Mr. Alfred King, formerly engineer to the company, was a pioneer in the application of gas to cooking purposes. Alfred King used luminous flames in his cookers, and the practice continued for many years, even as late as 1887, for in that year the late Mr. William Sugg (of London) gave a lecture in St. George's Hall, Liverpool, in the presence of the Mayor and a large audience, on cooking by gas, accompanied by a practical demonstration on a cooker fitted with luminous burners. On that occasion he paid a tribute to the pioneer work of Mr. Alfred King, from whom he had received his first instruction.

The extended use of gas for cooking did not make rapid headway in Liverpool until the company, in 1911, decided to let out cookers on simple hire. Since then many thousands have been fixed, and no fewer than 65,000 simple hire cookers are now on the district; while thousands of gas cookers have been sold outright and on the hire-purchase system. The modern gas cooker is deservedly popular, for it is reliable, clean, efficient and a great labour-saver, while it is simple and easy to control.

*Gas Fires.*—Gas appliances for heating rooms, offices, shops, etc., have been greatly improved during the last 25 or 30 years. The modern gas fire bears little or no resemblance either in appearance or construction to the first fires put on the market. While the latest pattern of gas fire is a highly efficient, convenient, hygienic and economical appliance—pleasing to the eye and giving out radiant heat—the old patterns (dependent mainly on convected heat) were ugly and inefficient, and sometimes evil-smelling and unhealthy. Fortunately, these old fires have largely found their way to the scrap heap, and the new types of fires which have taken their place are giving great satisfaction. They are now recommended and much used by the medical profession, and are becoming increasingly popular.

* H. S. Thompson, "The Evolution of the Gas Mantle."

*Heating Appliances.*—Similarly, appliances for domestic hot-water supply have been greatly improved in recent years, and their use greatly extended. For industrial heating gas is being used more and more. Its convenience, ease of control, saving in labour and fuel storage, reliability and availability at all times, are points increasingly appreciated by leading industrialists. The extension of the use of gas for such purposes has greatly increased within recent years.

*Gas for Power.*—The first attempt to use coal gas regularly for power purposes appears to have taken place about the year 1860. Since then the gas engine has undergone many changes, and is now more efficient than the steam engine. It requires no boiler, chimney, solid fuel or boiler attendant. As a prime mover, when a steady load is required, it stands supreme.

*Smoke Nuisance.*—Gas is playing an important part in mitigating the smoke nuisance in Liverpool. It is deplorable that, in these enlightened days, we still tolerate the emission of dense black smoke from the burning of raw coal, polluting the atmosphere, covering everything with grime, dirtying our linen, obscuring the sun's rays, causing fogs, destroying buildings, reducing vitality, and contributing in no small measure to the prevalence of lung disease. The more extensive use of purified gas and the residual smokeless fuel, coke, is gradually bringing about a better state of things. It is well to bear in mind, also, that the gasworks process has a higher thermal efficiency than any other process of utilizing raw coal, and therefore is a conserver of our national resources, which are, of course, limited. The demand for gas continues to grow year by year. Many thousands of new houses have been built since the termination of the war, and in nearly all of these gas appliances for cooking and heating have been installed.

*Electrical Competition.*—In 1895 an event took place which has had a considerable effect on the progress and policy of the Gas Company, viz., the purchase by the Corporation of the Electric Supply Co. Ltd. Since then the Corporation electricity undertaking has developed rapidly. Electrical competition has been good for the gas industry in many ways. It has stimulated the gas business considerably. It is a remarkable fact that, notwithstanding the competition of electricity for certain purposes, the output of gas in Liverpool has doubled during the last 24 years.

*Relations with Labour.*—The Liverpool Gas Co. employ about 2,500 workpeople, clerks and officials. The relations between the Board of Directors and their workpeople have been of a very cordial kind for many years. In 1911 a co-partnership scheme was instituted, which has helped to confirm the good relationship that has existed. The main features of the scheme are:—

On the part of the co-partner:—

(1) An undertaking to continue in the employ of the company for a definite period;

(2) An undertaking to use his best endeavours to promote the prosperity of the company.

The company, in return, agree to give employment for a definite period and to allow the co-partner a bonus on his wages, half of which is not withdrawable and is invested in the company's stock; thus giving the worker an opportunity to improve his position by becoming a stockholder in the company. At the present time there are 2,080 co-partners, and the money invested (including savings) amounts to £82,220.

*Longevity.*—Service with the company appears to be conducive to longevity. There have been many instances of very long service, a period of 50 years having frequently been attained. One servant of the company, William Hambleton, retired in 1020, after no less than 71 years' unbroken service with the company. This remarkable old man died in Bootle three years ago, aged 99 years and 9 months: only three months short of the century. He came of fighting stock, for both his father and uncle served under Nelson at Trafalgar, and at least fifteen of his descendants joined the colours during the Great War.

*Directors and Officials.*—To anyone who has carefully examined the available records there cannot fail to arise a feeling of respect for the ability and foresight of those who established the gas industry in Liverpool, and who in the past shaped its destiny and laid the foundations of its present prosperity.

Many notable citizens of Liverpool have served as Directors of the Liverpool Gas Co., and such names as Earle, Tinne, Bateson, Lawrence, Fletcher and Forwood have appeared in the minute books.

Following James Hargraves, who was instrumental in introducing gas into Liverpool, John Sadler became engineer. He was an intrepid aeronaut, and in 1817 crossed in a balloon from Dublin to Holyhead. He, unfortunately, met his death while engaged in a balloon ascent from Bolton Gasworks in September, 1824, having been thrown out of the balloon near Blackburn and killed. John King was appointed in 1824, but only lived to hold the position a short time. On his death in 1826 his brother Alfred was invited by the Directors to succeed. On the amalgamation of the two companies in 1848, under the title of the Liverpool United Gas Light Company, Mr. Alfred King was appointed engineer of the united company, a position he retained until his death in 1867, the total period of his service having been 41 years. He was succeeded by his son, Mr. William King, who retired from the company's service in 1904, after a period of 37 years. The name of King was associated with gas almost from its inception in Liverpool; for the name of Joseph King appears as a proprietor of the company in the act of 1818—a connection of 86 years.

In succession to Mr. Wm. King, Mr. Edward Allen (assistant engineer at that time) was appointed engineer, and held the position until his death in 1915.

Col. J. F. Robinson, who for a long time acted as treasurer, introduced the slot meter into Liverpool, a class of meter which has become very popular. There are no fewer than 100,000 prepayment meters now in use in the district supplied by the Liverpool Gas Company.

*Conclusion.*—The past history of the gas industry in Liverpool is one of steady progress and improvement.

Gas for light, heat and power has been of incalculable value to the community, and has had much to do with the wonderful industrial development that has taken place during the last 100 years. Its place in the future will be of even greater importance, as there is every reason to believe that the industry is destined to play an important part in the great fuel problems, which are only now beginning to call for urgent solution.

## Sheffield Illumination Society

On April 6th an interesting lecture was delivered before the Sheffield Illumination Society on "Modern Gas Lighting and Heating" by Mr. A. Wylie (Sales and Fittings Superintendent of the Sheffield Gas Co.). In the absence of the President (Mr. H. Lazenby), owing to illness, Mr. J. F. Colquhoun presided, and thanked Mr. Wylie for a most interesting and instructive lecture, to which it is hoped to refer more fully in our next number.

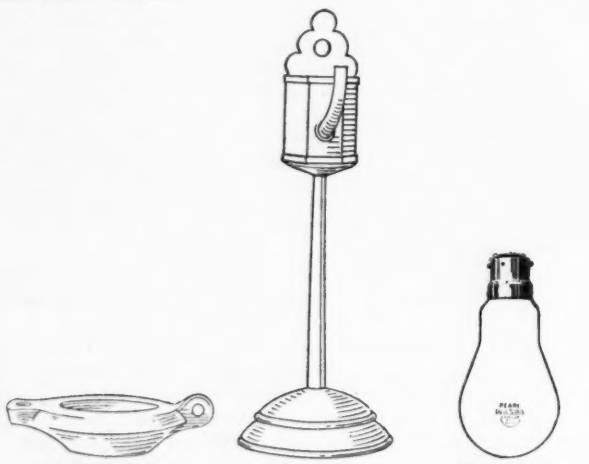
The Grimesthorpe Works of the Sheffield Gas Co. were visited by the members of the Sheffield Illumination Society on Saturday, May 7th. The arrangements for the visit had been made by Mr. Ralph Halkett, the general manager and secretary of the company.

The party was conducted through the works by Mr. L. Bates (Superintendent, Grimesthorpe Works) and Mr. Heap (Assistant). The various processes in the manufacture of gas and the extraction of by-products were fully explained, and the chemical works were also a feature of the tour. Mr. G. Sayer (treasurer) thanked Mr. Bates, Mr. Heap, and the management of the company for the facilities which had been made for their interesting and instructive visit. Mr. Bates replied to the vote of thanks, and expressed the pleasure which it had been to show the members of the Society the works.

# Lighting Methods of 25 Centuries

## From Saucer Lamp to Mazda

VERY few of us, who to-day enjoy the benefits of almost perfect artificial light, have ever given a thought to the methods of lighting employed by our ancestors of, say, 2,500 years ago. Nevertheless, this subject has aroused the keenest interest in many parts of the country where an interesting exhibition, illustrating the evolution of lighting, has been shown. This exhibit, which is the property of the manufacturers of the famous Mazda lamp, comprises actual examples of many of the different forms of lamps used over a period of 2,500 years, and brings home the fact that less than half a century ago the popular methods of lighting were substantially the same as those employed by our forefathers of 600 B.C.



**600 B.C.**
**Roman Pottery Lamp**
for burning vegetable oils.
(Sometimes called the Virgin lamp.)

**1600 A.D.**
**Flemish Oil Lamp**
for burning animal oils.
Still in use amongst the poorer classes of Central Europe.

**1927 A.D.**
**Pearl Mazda Lamp**
A gasfilled electric lamp which gives a very powerful light without glare or shadow.

The lamps include a Roman pottery lamp (often called the Virgin lamp) of the period 600 B.C., a Cyprolite saucer lamp used in Cyprus about A.D. 400, a Venetian stand lamp of the 15th century and a Flemish oil lamp of 200 years later. All of these lamps burned either vegetable or animal oils by means of wicks.

The 19th century opens with the tallow candle. Then, about the year 1830, came the whale-oil, double-wick lamp, known as the Franklin lamp, Benjamin Franklin having discovered that two wicks gave more than twice as much light as one. The paraffin oil lamp, which will be well remembered by the older generation, and of course is still extensively used in country districts, followed some years later. This was the first lamp to use mineral oil in place of the vegetable and animal oils which for centuries had provided the essential light and also, one fears, odours of an unpleasant character. Early in the 19th century coal gas had been discovered, and from the middle of that century was being used with a considerable measure of success for street lighting and, later, for house lighting. The cost of installation in private houses at first proved a formidable barrier to the adoption of gas in spite of its obvious advantages over oil lamps. The remaining lamps in the exhibit show the various stages of development of the electric lamp from the original carbon filament lamp invented in 1879 by that wizard of electricity—Thomas A. Edison—to the present-day Pearl Mazda gasfilled lamp, which provides a flood of beautifully soft light such as would have amazed and bewildered our grandfathers half a century ago.

Although the carbon filament electric lamp was introduced nearly 50 years ago it was not until 1909 that any further material progress was made. For many years the metal tungsten had been known by scientists to possess properties which made it ideal for electric lamp filaments, but unfortunately it was too brittle. Ultimately a pressed tungsten filament was evolved by combining refined tungsten (in powder form) with a suitable binding material. This resulted in the first metal filament lamp, having a very high efficiency when compared with the carbon filament lamp.

Then, in 1911, as a result of research in the Mazda laboratories, a method of drawing pure tungsten wire was evolved, which enabled an improved Mazda lamp to be produced. Of subsequent improvements perhaps the most noteworthy is the method of filling the lamp bulb with an inert gas, in combination with a closely coiled tungsten filament by which a greater amount of light is obtained for a unit of electricity than is given by an ordinary vacuum lamp. Another, in fact the latest, development is the internal frosting of the lamp bulb, by virtue of which an absence of glare is obtained equal to the best results given by any other method of obscuring, but with a considerably lower absorption of light. Both of these developments also have resulted from the continuous research of the Mazda laboratories, and their effect is seen in the modern Pearl Mazda lamp.

It is interesting to note that in less than 50 years the efficiency of electric lamps has been increased eightfold. The latest and largest type of Mazda gasfilled lamp gives nearly eight times as much light for the same amount of electricity as the original carbon filament lamp. Apart from the fact that this exhibit shows the method of lighting over a period of 2,500 years, it is additionally interesting because of the genuine antiquity of the older lamps.

## Venners' Twenty-First Anniversary

In our May issue reference was made to the fact that Messrs. Venner Time Switches Ltd. have recently "come of age," and on April 22nd a dinner was given by the company to commemorate the 21st anniversary of the firm. Mr. R. C. Graseby, the managing director, presided, and was supported by his co-director, Mr. E. E. Sharp. There was a representative gathering, which included Mr. W. W. Lackie (Electricity Commissioner), and Mr. J. R. Brooke (Central Electricity Board), Mr. J. W. Beauchamp (E.D.A.), Col. R. E. B. Crompton, and others prominently associated with the electrical industry. Mr. L. Gaster attended on behalf of *The Illuminating Engineer*.

The toast of "The Firm" was proposed by Mr. J. W. Beauchamp, who alluded to the enterprise shown by the firm in developing the time-switch in so many ingenious directions, and to its activities in different parts of the world. Mr. P. A. Maydwell, the works foreman, who was asked by Mr. Graseby to respond for the employees, mentioned various incidents to illustrate the cordial relations existing between the management and the staff, and Mr. Graseby, in returning thanks, gave an interesting survey of the progress of the firm during the past 21 years. Mr. F. E. Sharp proposed the toast of "The Electrical Industry," which was responded to by Mr. Laskie and Mr. Brooke, both of whom expressed their conviction that substantial progress in electrical developments were impending.

All those present at the dinner were presented with a little souvenir, in the form of a neatly printed brochure containing a history of the firm, with illustrations of Mr. Venner, the founder, and of Mr. Graseby and Mr. Sharp, the present directors.

## Floodlighting of Private Houses

The floodlighting of stores and important public buildings is becoming very popular, but the idea of applying it to private houses—apart from model "electric homes" and demonstration houses—is something new. It appears, however, that the method is coming to be used by real estate companies in the United States. *The Electrical World* presents an illustration of a house so lighted in Louisville. Most of the installations continue in use for six to eight weeks, and they are regarded as a valuable form of publicity.

The Café Verrey, Regent Street, London, W.
Main Restaurant. An Example of Modern Restaurant Lighting.

## A Pleasing Restaurant Lighting Installation

The days when a hard and glittering effect was desired in restaurant lighting seem to be passing. This was a temporary phase, arising from general deficiency in light. To-day, when artificial light is so much more abundant, proprietors recognize that distinction is best achieved by artistic and pleasing effects, and "soft" lighting is the rule. Unscreened bright sources are no longer tolerated in the best restaurants, and efforts are made to utilize harmonious colour effects.

This is well illustrated in the above view of the Café Verrey, in Regent Street, London. The entrance hall and lounge are illuminated by means of a massive English alabaster central ceiling fixture, supplemented by flambeau fittings on the walls. The main restaurant lighting (shown above) is carried out by means of three suspended fittings, with 36 in. cut-glass bowls, surrounded by hand-painted silk valances, and a number of wall brackets. There is no doubt that the wall brackets and the lights on the pillars perform a useful service in supplementing the central lighting. In the ballroom seven large mahogany fittings, with hand-painted silk shades, and single and double mahogany wall brackets are used. As dancing forms one of the chief features in this restaurant, special consideration was paid to the form of lighting employed in order that the many beautiful dresses worn by the ladies should be shown to the best advantage. This is a point to which the management attach much importance—as many patrons object to any form of lighting which, by its harshness, dissipates the art of the dress designer and tends to lessen the effect of pleasing creations.

Mr. Victor Collard, who is installed for the purpose of instruction in dancing, has expressed his entire approval of the lighting arrangements.

All the fittings referred to above were specially designed and made by the General Electric Co. Ltd., and Osram gasfilled lamps are used. The installation was carried out by Messrs. Foote & Milne, of Stockwell Road, S.W.

## Protection for Silk Shades

The silk shade has for long had a strong hold on the affection of the public for domestic lighting, and its popularity shows little signs of diminution. During recent years much art and ingenuity has been expended on its design, and many pleasing forms are now available. It has, however, at least one obvious drawback, the liability to collect dust and quickly become shabby unless carefully looked after. A firm in Germany has accordingly brought out a simple form of "glass skin" which can be mounted over the silk and protect its exterior. It appears that both the shade and the glass envelope are conical, so that the latter can easily be slipped over the former. The device would seem more difficult to apply to a shade of somewhat more complicated shape, as the glass covering would have to be specially made for each design. In this country specially effective protection is afforded in those semi-indirect fittings in which silk is introduced between the prismatic reflector and a plane glass outer hemisphere.

***Every Member of the I.E.S.***
*should certainly have a copy of the* 1927 *edition of*
***"The Practical Electrician's Pocket Book"*** **602 pages for 2/6** Postage 4d.

Indispensable to everyone whose business is connected with illumination, it is full of valuable information and tables. There is a list of Central Stations, their voltages and charges, a Glossary of B.S. terms and many pages devoted to the different methods of illumination. A book you must have. Get it direct from:

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**38c Maiden Lane, Strand, London, W.C.2**

# Developments in Stage Lighting

**A Visit to the Works and Showrooms of the Strand Electric and Engineering Co. Ltd.**

DURING a recent visit to the works and showrooms of the Strand Electric and Engineering Co. Ltd., at 24, Floral Street, London, W.C., the writer had an opportunity of seeing some of the latest stage-lighting equipment in operation and hearing something of recent installations. One little device—less simple in design than it appears—is the disappearing footlights installed at the Arts Theatre Club (Great Newport Street, near Leicester Square)—the enterprising organization where new pieces are constantly "tried out." The footlights are mounted on a pivoted board, which forms part of the stage floor when the lamps are not in use. They are brought into operation by a worm-wheel control in the orchestral pit, which enables the board to be tilted at any desired angle, and the reflectors used are of special contour and design, being shaped scientifically so as to meet all requirements as regards the illumination of the artist, no matter which part of the stage he may be on. While examining this device at the Arts Theatre Club we were also interested to note the use of "Baby Spot" projectors mounted on the face of the gallery, for use with some scenes where the footlights are dispensed with, thus leaving an apron stage.

We understand that the firm has recently been responsible for the installation of a considerable amount of new lighting floats at Drury Lane Theatre, and has likewise taken an active part in the lighting of scenes during the present run of grand opera at Covent Garden. A feature on this occasion was the substitution of 3,000-watt gasfilled lamp projectors for the usual arc lamps—the largest unit of this type to be used for stage lighting in this country. The use of incandescent lamps instead of arcs has certain advantages, notably the ease with which the lighting can be modulated by dimmers.

Yet another interesting installation has been the lighting, provided with the co-operation of *The Daily Sketch*, for the great boxing contest at the Albert Hall, in which Teddy Baldock took part. We were shown photographs taken by the artificial light and illustrating the very high illumination provided—derived from 45 1,500-watt gasfilled lamps in concentrating reflectors mounted immediately over the ring. The provision of such high illuminations to enable photographs to be taken, without unduly interfering with the boxers, is always a difficulty. But the present arrangement had the advantage that sources are screened from the eyes of the audience, and, being well above the line of vision of boxers, do not cause them trouble.

In the showrooms we noticed several new models of floodlights equipped with reflectors specially designed to give a wide spread, and a specimen of the ingenious automatic illuminated fountain which is now frequently used for scenic displays, and in dance halls, conservatories, cinema lounges, etc. Another device was the automatic colour spotlight, the disc of which, carrying the series of coloured gelatines, rotates by clockwork slowly when the current is switched on, but can be brought to a stop in any desired position. This is often very convenient to the operator, who can set the disc so as to give the colour wanted from a distance, without having to leave his station and return. The writer was also given a display of the effect of light from a batten of coloured lights on a screen decorated with silks of various hues. The colours of the silks were specially selected with a view to changes in apparent tint under varying quality of light, and the transformations as the successive colour changes took place were most effective—a better illustration of the need for careful combination of the colours of objects and scenery and the colour of light illuminating them could scarcely be conceived.

Lastly, the writer was shown a very modern and ingenious type of switchboard, exactly similar to that recently provided for the Theatre Royal, Glasgow. The latter was so effective that duplicates for use in quite a number of other theatres have since been ordered, and two of these were seen nearly completed, for the King's Theatre, Glasgow, and Lyceum Theatre, Edinburgh. The chief feature of the board is the manner in which it is designed so as to be within the complete control of a single operator. The assembly of the circuits, switches, etc., has been carefully thought out to make everything as simple as possible for the operator, who is further aided by the colour scheme distinguishing the various circuits. One special feature is that every stage socket for local stage units has its own separate switch instead of several being controlled together, as is not infrequent in theatres. There is also a similar stage switchboard nearly completed for the New Theatre, Cambridge, where the Strand Electric Co. are also fitting an entire new stage-lighting installation.

## Recent Restlight Installations

We understand that a number of specially interesting installations of "Restlight" units have recently been arranged. Readers will recall that one of the chief claims made for these units is that the quality of the light, which resembles sunlight visually, is particularly restful to the eyes, owing to the elimination of the excess of red and orange in the spectra of most artificial illuminants. From this standpoint it is considered to be specially adapted for processes involving somewhat severe visual effort, and is being installed throughout in the L.C.C. School of Printing. Another installation now being undertaken is the lighting of various sub-basement rooms in the Office of Works building, where a light capable of "mixing" with the limited daylight available would presumably be advantageous.

The "Restlight" is not regarded primarily as a colour-matching unit, but at the same time the appearance of colours by this light is very much better than by ordinary uncorrected light, whilst the absorption of light involved in the process of correction is small in comparison with that inevitable in the accurate colour-matching units. "Restlight" units are therefore finding a ready application in picture galleries. A notable installation is that being made in the Raphael Art Gallery in the Victoria and Albert Museum, and we understand that it is also being applied in the National Gallery. Yet another new development is the application of "Restlight" glass with suitable projector units for portrait photography; here they appear to have special advantages.

Messrs. Halsted, Hanby & Co. Ltd., from whom we learn the above particulars, also report that considerable progress is being made with the development of "Vitaglass," the permeance of which to ultra-violet light of moderate wavelength is regarded as highly beneficial to health. About thirty hospitals are already adopting the glass, and approximately 120,000 square feet of it are being installed in London alone. An important step has been the production of the glass in large sheets, with a smooth and polished surface, quite resembling ordinary glass in appearance. Experiments have also been made with the glass at Kew, and although the present season is not very favourable to experiments, promising results have been obtained, a feature being the quicker development and deeper colouration of the foliage of plants grown under glass of this nature.

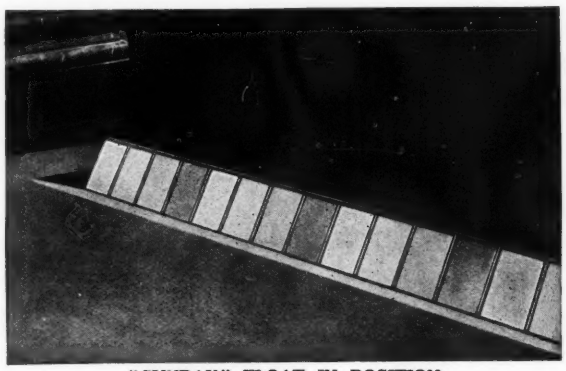
S·E·E·C·O·L

MODERN STAGE LIGHTING APPARATUS

THE MOST ECONOMICAL AND EFFICIENT STAGE LIGHTING EQUIPMENT YET DEVISED

"SUNRAY"

THE BEST AND BRITISH MADE



"SUNRAY" FLOAT IN POSITION

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NEW ARTS THEATRE
FORTUNE THEATRE
THEATRE ROYAL, GLASGOW
ALHAMBRA, GLASGOW
KING'S THEATRE, GLASGOW
LYCEUM THEATRE, EDINBURGH
NEW THEATRE, CAMBRIDGE
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(per the Berkeley Electrical Company, Ltd.).

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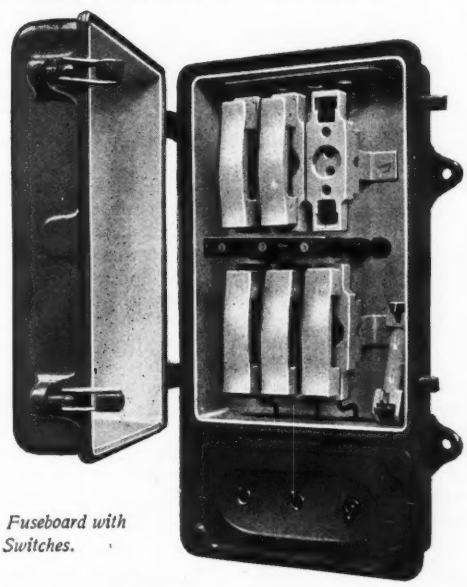
SWITCHGEAR KAR TRET COMPANY LTD

DISTRIBUTION FUSEBOARDS WITH SWITCHES—5/10 AMP.



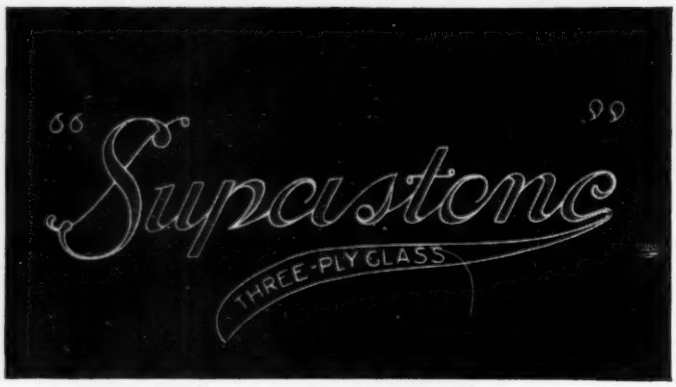
10 *Amp. D.P. Fuseboard with*
10 *Amp. S.P. Switches.*

SWITCHES IN SEPARATE COMPARTMENT

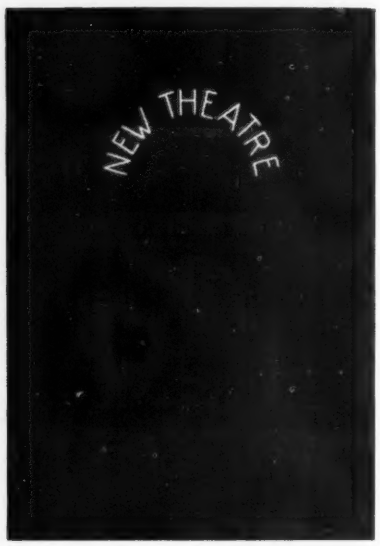
# TRADE NOTES & ANNOUNCEMENTS

## NEON SIGNS.

We recently received from Messrs. Philips Lamps Ltd. some data regarding the Philips Neon Signs, together with illustrations which show designs of widely different characters. The penetrative power of light obtained and the small cost of upkeep are, of course, salient features of neon signs. The vividness of the colour of neon lighting is such that the sign stands out conspicuously. It arrests attention, and can be easily read from a great distance—even in foggy weather. At the same time there is an absence of dazzle and heat. The signs can be supplied in three different colours, i.e., red, blue, and green. It is pointed out that the neon signs




Example of Neon Sign with Script Lettering.
Installed on the Premises of Wholesale Fittings Ltd., Commercial Street, E.




Example of Neon Sign with Block Lettering.
Installed at The New Theatre, Boston, Lincs.

can be run at an exceedingly low cost. Messrs. Philips Lamps Ltd. make a special point of guaranteeing all their neon tubes for one year, estimating a year to be equivalent to 1,800 burning hours. In actual practice this figure has been exceeded by 100 per cent. and more before it has been necessary to have the tubes repumped with new gas.

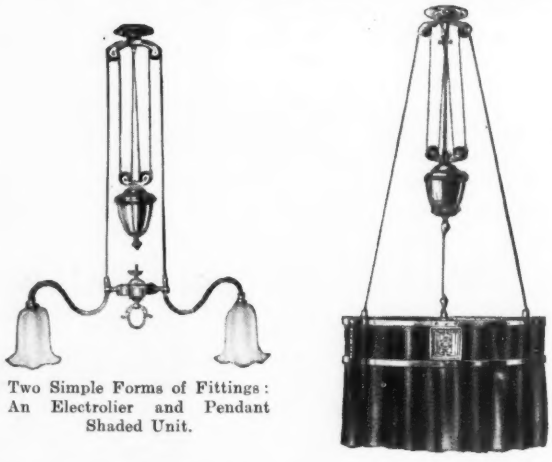
Owing to the patented construction and connection of the tubes, steady light without the least flicker is assured. Further, the tubes are not affected by the continual incandescing and nigrescing (which is detrimental to the tubes, transformer and cable) due to the fact that they are run with high-tension resistances which give an efficient damping effect to oscillations. The standard high-tension voltage on which the signs burn is 3,500, and the consumption of a 13-mm. diameter tube having a 10-ft. run is only 90 watts. This diameter tubing is normally used for the signs, but tubes are also made having 7-mm., 10-mm., 16-mm., 20-mm., 25-mm., and 30-mm. diameter, and the consumption for various lengths will fluctuate accordingly.

In addition to the ordinary type of neon sign, Messrs. Philips Lamps Ltd. manufacture box signs having tubes on one or both sides, as desired, in red, blue, or green colour, all the electrical accessories with the exception of the rotary converter (if necessary) being contained therein.

Another form of sign is the " Mignon " case sign, the tubes of which are worked off an induction coil connected to a 6 to 8-volt supply. They will operate from a 6 to 8-volt accumulator where only direct-current supply is available, but in the case of alternating current a low-tension transformer is utilized. Here, again, tubes can be supplied giving red, blue, or green colours, in block or script formation as desired. This form of sign is very much cheaper to produce than the above-mentioned, as no high-tension transformers, resistances, etc., are necessary. Moreover, the daylight appearance is greatly enhanced by the fact that the neon tubes are recessed in the wooden background, and all the necessary accessories are contained in the case, the whole forming an entirely self-contained sign. The " Mignon " sign is particularly suitable for use above entrances, shop windows or show cases, and in all situations where a small and inexpensive sign is required.

## THE DECORATIVE VALUE OF ELECTRIC FITTINGS.

A leaflet received from the British Thomson-Houston Co. Ltd. points out that most women look forward to an occasional change in the decorative scheme of the home. At this season of the year spring cleaning, papering and general renovation are commonly taken in hand. The existing furniture is often re-upholstered to suit the new scheme, or new furniture may be purchased. Electric fittings, which have themselves considerable decorative value, should therefore not be overlooked. There are considerable advantages in installing new fittings when other renovations are in progress, and the issue of this list, which contains views of many inexpensive and attractive designs, is therefore timely. Two typical varieties are shown in the accompanying illustrations.



Two Simple Forms of Fittings: An Electrolier and Pendant Shaded Unit.

## CONTRACTS CLOSED.

The following contracts are announced :—

MESSRS. SIEMENS AND ENGLISH ELECTRIC LAMP CO. LTD. :

*Port of London Authority;* for Siemens gasfilled lamps for period of six months ending September 30th, 1927.

*London County Council;* renewal of contract for the supply of the whole of their requirements in electric incandescent lamps for a period of 12 months.

GENERAL ELECTRIC CO. LTD. :

*Bolsover Colliery Co.;* for Osram metal-filament and Robertson carbon-filament lamps, nine months' contract.

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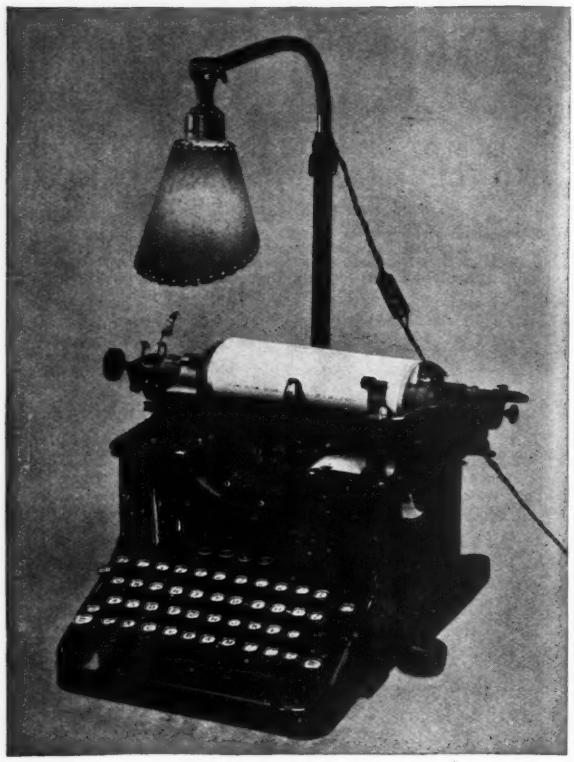

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## AN ILLUMINATED DANGER SIGN AT HENDON.

Progress in the direction of illuminated traffic signs is illustrated by the accompanying picture of a danger sign at Hendon, showing a day and night view. The system of illuminating this sign was developed as a result of a conference between Mr. A. O. Knight, the Surveyor of the Hendon Urban District Council, with the G.E.C. lighting engineers, and it is being installed at various danger spots, with the co-operation of the Hendon Electricity Supply Co.

Day and Night View of Hendon Danger Sign.

The particular sign illustrated is used on the Watford By-pass Road. Tests have shown that it can be distinguished easily 500 yards away in clear weather and 200 yards away in fairly heavy fog; owing to the sharp contrast between the illuminated sign and its background, the sign is possibly even more easily distinguished by night than by day. The illumination is effected by the use of a 20-watt red colour-sprayed Osram sign type lamp, fitted at the apex of the red triangle, and a 20-watt Osram squirrel-cage vacuum lamp, fitted to a 6-in. enamelled-steel reflector, which is fitted centrally below the base of the triangle so as to illuminate the design and wording. The lamps are automatically controlled by a standard G.E.C. time switch.

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## LIGHTING EQUIPMENT IN CARDIFF SCHOOLS.

We understand that considerable progress has recently been made towards the improvement of lighting in the schools of the Cardiff Corporation. The changes are being carried out by local contractors to the specification of the City Electrical Engineer, Mr. Morley New. Of the eight elementary schools and five secondary schools so far dealt with seven have been equipped with B.T.H. Veluria shades, three with Holophane glassware, and three with mixed types of reflectors, obscured lamps of 60 and 100 watts being used. Special attention is being devoted to even illumination and absence of glare. At the same time the lighting of various halls and other public buildings in Cardiff is also receiving attention.

## FLOODLIGHTING.

The Electric Illumination Bulletin Handbook No. 6, issued by the E.L.M.A. Lighting Service Bureau, is devoted to floodlighting. Much of the matter is based on the informative paper recently read by Mr. W. J. Jones before the Illuminating Engineering Society,* and the booklet should prove a very useful guide. After an introductory explanation of engineering principles, in the course of which the operation of the mirror is discussed and the different forms of floodlighting units illustrated, a table showing the illumination necessary for different classes of buildings is presented. In another table the spread of the chief forms of projectors and the resultant utilization efficiency is stated. The final section of the book, dealing with installations, describes a great variety of uses to which projectors may be put.

For the frontispiece there is a colour reproduction of the floodlighting in colour of the Royal Pavilion, Brighton, which makes a very effective picture.

* *The Illuminating Engineer*, Jan., 1927, pp. 5-13, and Feb., 1927, pp. 37-44.

# REVIEWS OF BOOKS AND PUBLICATIONS RECEIVED

THE GAS SHOWROOM, *by F. Cornelius Wheeler, with a Preface by Sir D. Milne Watson.* (*Ernest Benn Ltd., London, 1927, pp. 115, 7s. 6d. net.*)

A brief preface by Sir David Milne Watson, Governor of the Gas Light and Coke Company, emphasizes the vital importance of well-designed showrooms to the gas industry, and in the first chapter his recent remarks on this point are quoted in detail. (A small discrepancy may here be noted; in Chapter I Sir David is still referred to as Mr. Milne Watson, though the title is correctly given in the preface.) Gas showrooms are attracting much attention at the moment, and the issue of this book is therefore timely. In subsequent chapters the choice of the site, planning and lay-out, decorative treatment, ventilation and heating, etc., are discussed in turn, and the author's remarks are aided by many good illustrations of typical modern showrooms. In a final chapter hints on organization and salesmanship are given, and in an appendix the views of other gas engineers on the importance of up-to-date showrooms are quoted. There is no doubt that the book contains many useful suggestions, especially in the section devoted to decoration. As the author remarks, a gas showroom is not a "shop" in the ordinary sense, and dignified treatment is desirable. A chapter is devoted to "Economy" gas flue systems. One cannot help thinking that a little more might have been said about lighting. The author contends that gas lighting is far from moribund, but he does not seem to emphasize sufficiently its possibilities in the showroom. The appeal to the eye of good illumination is a valuable weapon, and in the model showroom, which is essentially a demonstration centre, lighting arrangements deserve very careful study.

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